THE SMART SUBDIVISION: RESIDENTIAL APPLICATIONS OF IVDM™ TECHNOLOGY

Alberta
MUNICIPAL AFFAIRS
Innovative Housing Grants Program


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THE SMART SUBDIVISION: RESIDENTIAL APPLICATIONS OF IVDM™ TECHNOLOGY

April, 1987

Prepared by:

Teletronic Communications Ltd.

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FOREWORD

The project documented in this report received funding under the Innovative Housing Grants Program of Alberta Municipal Affairs. The Innovative Housing Grants Program is intended to encourage and assist housing research and development which will reduce housing costs, improve the quality and performance of dwelling units and subdivisions, or increase the long term viability and competitiveness of Alberta's housing industry.

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As the type of project and level of resources vary from applicant to applicant, the resulting documents are also varied. Comments and suggestions on this report are welcome. Please send comments or requests for further information to:

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EXECUTIVE SUMMARY

Recent advances in computer and communication technologies are revolutionizing life in modern society. These changes are referred to as the coming of the "Information Age". Until recently, the implementation of electronic services for home use has been limited due to the high costs of personal computers, modems and various related services. Fortunately, the development of an **Integrated Video and Data Multiplex (IVDM™)** communication system by TeleTronic Communications Ltd. of Edmonton, Alberta offers to extend the range, utility and affordability of electronic services, making them viable for home use.

IVDM™ is a new concept in communications. It employs techniques that extend conventional technology to provide high capacity information capabilities at a low cost. It has been developed by applying standard telephone engineering techniques to computer and cable television distribution technologies. The result is a comprehensive, interactive communications system capable of supporting any mix of voice, video and data services to solve many communication needs in the residential sector.

IVDM™ can provide many new electronic services hitherto unavailable in the home. The application of this advanced technology in the residential sector will enable the creation of a "Smart Subdivision" through the provision of integrated residential communication networks for the simultaneous delivery of previously separate telephone, cable television, computer, security and utilities management services over a single transmission facility. This will result in lower tariffs for an enhanced variety of entertainment and information services: pay-per-view TV, home banking, teleshopping, videotex, on-line database access, personal computer communication services, electronic mail and many others. As well, IVDM™ technology can interface with Smart House℠ wiring arrangements to extend the

operation of electronic house control features to the subdivision level, thereby creating the truly automated home of the future.

In order to demonstrate IVDM™'s advanced capabilities in an operational setting and generate local interest in the technology, TeleTronic has developed a detailed installation plan for installing equipment and cable required to implement a Smart Subdivision trial for a representative Edmonton community. Involving approximately 5000 communication connections, the trial community will encompass a normal range of homes, businesses and institutions. At an estimated cost of $ 1123 per communication connection, IVDM™ provides a level of service superior to that of "hybrid" telephone/one-way cable television systems.

The application of IVDM™ technology in Alberta will yield considerable benefits for residential and non-residential users alike. IVDM™ will contribute to improving the quality of home life, reduce the cost of residential site servicing and generate many opportunities for spin-off economic activities. As well, IVDM™ technology can be implemented for commercial, educational and institutional applications, generating equally significant cost savings and other benefits.

TeleTronic has assembled a prototype IVDM™ system which is available for demonstration and viewing at the Company's research and development headquarters in Edmonton. The Company encourages property developers, cable television operators, telephone companies and other interested parties to study this report and arrange to view the demonstration system by contacting:

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THE SMART SUBDIVISION: RESIDENTIAL APPLICATIONS OF IVDM™ TECHNOLOGY

1.0 INTRODUCTION

The merging of computer and communications technologies is revolutionizing life in modern society. This can be seen in nearly all facets of everyday life, the widespread utilization of mainframe and personal computers, the introduction of interactive services such as "teleshopping" and "telebanking", the advent of new communication services such as "electronic mail", and the implementation of hybrid telephone and data communication networks. This phenomenon has been referred to as the coming of the "Information Age". It was first evidenced by the implementation of advanced electronic services for the automation of contemporary offices and factories. Now the new electronic media are available for home use as well.

Until recently, the implementation of electronic services in the residential sector has been somewhat limited as a result of the high costs associated with personal computers, modems, online database access and various related services. Since these costs must be borne by the consumer, home electronic services have not attained the high degree of user penetration which otherwise would extend their range, utility and affordability as required for implementation on a large scale. Fortunately, the development of an **Integrated Video and Data Multiplex (IVDM™)** communication system by TeleTronic Communications Ltd. of Edmonton, Alberta offers to substantially extend the range, utility, and affordability of electronic home services.

Within the home, IVDM™ can provide the communications medium over which Smart House℠ control features can be extended. According to the National Association of Home Builders Research Foundation in Rockville, Maryland, the Smart House℠ wiring system will consist of an integrated power and signal wiring and control system which will replace the redundant and expensive collection of wires and electrical components built into

conventional homes. By defining a single communications protocol for power, signal carriers, sensors, controls and input-output devices, the cost of home electrical and electronic functions can be reduced while their capabilities are extended. Cost savings will arise through: consolidation of the various control and timing functions into a single processor; conversion of other electrical devices to solid state electronics; and, the elimination of separate wiring for telephones, doorbells, security systems, cable television, thermostats and the like.

When interfaced with an IVDM™ network, the Smart House℠ can have access to many new electronic services, resulting in simple yet useful applications for the household at low cost. The IVDM™ equipped home can also enjoy various entertainment and interactive data services such as pay-per-view TV, electronic mail, home banking, home shopping, and personal computing services, in addition to telephony, automated meter reading, energy and load management, alarm monitoring, and other security services. All these are provided over a single communications network shared among many homes. Consequently, IVDM™ can compliment and enhance the Smart House℠ features.

The application of IVDM™ technology in the residential sector will extend the Smart House℠ type control technology to the subdivision level and beyond. This approach envisions the creation of integrated residential communication networks for the joint provision of previously separate telephone, television, computer, security and utilities management services over a single communications channel. The integration of all voice, video and data services over a shared set of electronics can significantly reduce the capital costs associated with systems duplication inherent in conventional communication site servicing. This will flow to residential consumers in the form of lower building costs as well as lower tariffs for an enhanced variety of communication and information services.

The IVDM™ Smart Subdivision approach represents a significant development in communications for the residential sector because it extends the affordability, utility and availability of electronic services which make contemporary residential life safer and more convenient, especially for two-income earning families, students, the disabled and the elderly. The Smart Subdivision network also gives residential consumers the capability to connect home computing facilities with those in remote locations such as schools and the workplace, at much higher data transmission rates and without the requirement of an expensive personal computer and modem in the home itself. This makes the concept of "telecommuting" a realistic possibility. In these respects the implementation of the Smart Subdivision concept will enable what many have referred to as the "Electronic Cottage".

1.1 Objectives of the Study

Using a variety of public information sources and proprietary technical documentation, this study explores the potentials, costs and benefits of applying residential IVDM™ technology. Specifically, the research will:

1) document IVDM™ system basics;
2) describe potential residential applications and services enabled by the technology;
3) investigate and cost alternative technologies capable of providing equivalent services and compare them with IVDM™;
4) outline an approach to implementing an IVDM™ System trial involving 5000 communication connections;
5) develop an IVDM™ System installations diagram for a typical community;
6) estimate hardware, installation and operating costs associated with the potential service offerings;
7) evaluate the residential market for IVDM™ technology in Alberta, Canada and many foreign markets; and,

8) examine regulatory issues relevant to the application of IVDM™ technology in the residential sectors of Alberta, Canada and major international markets.

1.2 Previous Implementations of New Electronic Home Services

Past attempts to implement affordable electronic services in the residential sector have not met with lasting success, chiefly because they have involved expensive, piecemeal solutions to general purpose communication problems. Typically lacking has been an integration of services over a shared network. Upstream services such as remote meter reading and load shedding have been implemented over the telephone system, while video services have required a separate, higher bandwidth coaxial cable network.

Attempts to offer remote meter reading and load shedding include a late 1970s trial in Edmonton involving "edmonton telephones" and Control Devices. A similar trial was conducted in Hackensack, New Jersey, involving New Jersey Bell and the Hackensack Water Company. In such trials where cost controls were crucial, the preferred medium was the twisted copper wire telephone exchange because of the relative ease of installing the necessary interface and relay equipment at the telephone system head end. The telephone companies themselves often were major participants who sold their services to various interested utility companies.

However, due to the bandwidth limitations of twisted copper wires, the analog telephone system could not support the simultaneous transmission of voice and data signals over a single telephone line. While this was not a problem for meter reading and load management purposes, the highly sensitive response time requirements of alarm monitoring services could not be fulfilled if an upstream alarm signal coincided with a voice transmission or an out-of-service home phone line. This required separate pairs of wires be used in each home, which resulted in higher costs.

Contention has posed similar problems for the provision of interactive data services such as videotex, home banking and on-line computer access over the telephone system. It has forced many home users to obtain additional phone lines, which contributes to increasing the cost of such services. Low-speed data transmission rates (300 - 2400 baud) also have been problematic. For example, the dismal failure of Telidon is partially attributable to painfully slow data transmission rates.

Another feature unattractive to many potential residential users of Telidon and other videotex services has been the utilization of expensive dedicated user terminals which can accommodate only one particular service. Naturally, this makes a service such as Telidon prohibitively expensive for the typical consumer. On-line computer services access is similarly cost-prohibitive, because home consumers must purchase modems in addition to paying high usage charges to the public data networks and to the service providers as well.

Due to its high bandwidth capability, broadband coaxial cable used in cable television networks has become the preferred transmission medium for upstream and two-way services, at least for the foreseeable future. However, because conventional transmission equipment has been designed primarily for downstream video applications, most existing cable TV networks can accommodate only one-way (downstream) signals. Attempts to implement upstream and/or two-way services have resulted in unacceptable noise gathering and reliability problems.

Progress to date on the development of two-way coaxial cable TV systems and addressable convertors promises to overcome these problems. This will pave the way for integrated two-way communication systems capable of providing homes with the full range of communication services over a single network. In fact, MCI Communications currently is conducting a trial known as Cablephone, a project involving several two-way cable TV operators who are interested in expanding their revenue bases by offering long distance telephone services through MCI.

IVDM™ successfully solves the upstream noise gathering and reliability problems of traditional one-way coaxial cable networks. It also overcomes the bandwidth limitations and contention problems of conventional telephone systems. IVDM™ has been designed as a transparent communications network which supports all home video, voice and data services. This enables the provision of a full range of differentiated services capable of satisfying various residential demand sectors, at costs affordable to the typical user.

IVDM™ is completely independent of any particular service. A service such as Telidon would be merely one of many services accessible from within the home, and at a much more economical cost. In fact, IVDM™ can provide the Smart House℠ with a virtually unlimited variety of new electronic services which in the near future will be offered by the so-called "Fourth Utility" communications network of the Information Age. Consequently, the IVDM™ Smart Subdivision approach will represent a substantial improvement over previous attempts to deliver home electronic services.

2.0 THE IVDM™ SYSTEM

Integrated Video and Data Multiplex (IVDM™) is a new concept in communications. It employs techniques that extend conventional technology to provide high capacity information capabilities at a low cost. It has been developed by applying standard telephone system engineering techniques to both computer and cable television distribution technologies. The result is a comprehensive, interactive communications system capable of supporting any mix of voice, video and data services to help solve many useful communications needs in the residential sector.

2.1 Objective of the IVDM™ System

IVDM™ was originally developed in response to a key techno-economic question of the new Information Age. That is, how can a telephone company, cable television operator or property

developer implement a local communications network to carry a full range of advanced services, such that each service incorporates the features necessary to meet user demands and yet is economically sustainable at a tariff for each service that is within reach of the typical consumer? Answering this meant designing a system which:

(a) uses a single "drop", or cable, to each subscriber;
(b) can be retro-fitted easily into existing networks or installed as a new system build;
(c) shares expensive electronic components so as to be cost effective for all service offerings;
(d) is sufficiently flexible and open-ended to remain operationally viable for the foreseeable future;
(e) is compatible with existing and future analog and digital switching and video equipment; and,
(f) interfaces with existing and future broadband networks as well as with public telephone exchanges.

IVDM™ incorporates many operating and design features to successfully achieve these objectives. These features are critical to the efficient and cost effective operation of IVDM™ in the Smart Subdivision.

2.2 Basic Principle of Operation

IVDM™ takes the two-way capability of conventional telephone systems and applies it to cable television distribution technologies. This two-way capability enables the provision of interactive services such as home banking and pay-per-view TV. By utilizing broadband coaxial cable (or optical fibres) capable of transmitting a very wide range, or bandwidth, of signals in two directions simultaneously, the System also takes advantage of the high information carrying capacity of cable television networks. This enables the integration of all communication services; voice, video and data, over a single transmission network.

In order to deliver two-way services over a broadband coaxial cable network, IVDM™ utilizes the "subsplit" approach, whereby four or more video channels are reserved for transmissions sent from residential users to the Smart Subdivision central office. This is referred to as "upstream transmission". The remaining thirty or more video channels are used to send information in the opposite direction, from the central office to the subscriber terminal. This is referred to as "downstream transmission".

It has been recognized for some time that there is a market for two-way communication services in residential cable TV networks. This market includes many interactive services in addition to pay-per-view TV, such as home shopping, electronic mail, personal computer and software services, and various remote Smart House type services requiring noise free upstream transmissions. The flexible configuration of intelligent switching components within the IVDM™ architecture enables the provision of these two-way services without the high costs, unreliability, overload and noise problems associated with past attempts to achieve this capability over conventional telephone systems and one-way cable TV networks.

2.3 Principle Operating Components and Their Functions

IVDM™ consists of a hierarchy of four intelligent, micro-processor based switching nodes capable of handling internal voice, video and data switching services where required. They are configured to distribute network resources to handle upstream and downstream signals in the most efficient and optimal fashion for a particular Smart Subdivision. The four components are:

1) Distribution Control Terminal (DCT),
2) Intermediate Distribution Terminal (IDT),
3) Remote Video and Data Multiplex Unit (RVDM), and
4) Subscriber Terminal Unit (STU).

2.3.1 Distribution Control Terminal (DCT)

The highest level in the IVDM™ switching hierarchy is the Distribution Control Terminal or DCT. The DCT acts as a master controller for the Smart Subdivision network, constantly monitoring incoming messages. It contains the standard digital trunk interfaces connecting IVDM™ to the local telephone network. The DCT also provides interfaces to television programming sources, video library sources, various information service providers and any special equipment for implementing pay-per-view TV services.

On the downstream side, the DCT receives incoming signals from these sources and transmits them to the coaxial cable or optical fibre trunk for distribution to users. On the upstream side, the DCT receives data from users and accordingly transmits voice traffic to the telephone network and relays other data traffic to various data networks, service providers and databases. Voice, video, and data messages between users within the same IVDM™ network are switched internally at various levels in the hierarchy.

The DCT performs other functions as well. It constantly polls the Intermediate Distribution Terminals for indications of any malfunction, performs the necessary maintenance functions for the IDTs and undertakes its own maintenance routines as well. The DCT also connects to a computing facility (mini or mainframe) called the Central Computing Complex (CCC) that provides accounting and billing, on-line database and computer services access, and interface to various utilities and fire/burglar alarm control centres servicing the Smart Subdivision.

2.3.2 Intermediate Distribution Terminal (IDT)

The Intermediate Distribution Terminal or IDT is located along the distribution network trunk in much the same fashion as a typical cable TV amplifier. It can be used anywhere in the IVDM™ network to extend lines when connecting additional

components at lower levels in the hierarchy. By regenerating signals on long runs through a complex series of frequency conversions, the IDT acts as a delimiter of upstream noise ingress. Like the DCT, the IDT also polls lower-level units connected to it, performs their maintenance functions and also undertakes its own maintenance routines.

2.3.3 Remote Video and Data Multiplex (RVDM) Unit

The Remote Video and Data Multiplex (RVDM) unit interfaces the Subscriber Terminal Units (STUs) to the Smart Subdivision network. Since the RVDM serves up to sixteen STUs, it is the most active switching node in the hierarchy. The RVDM monitors the STUs for user service requests and either handles the requests itself or relays them further up the hierarchy. This component also monitors the STUs for indications of malfunction, cut wires, etc., in order to enhance the security and reliability of the System. It also performs its own maintenance functions. The RVDM scans incoming messages and distributes them only to the user(s) for which the messages are intended. This switching node also contains any shared resources, such as personal computing and channel convertor modules, which are accessible by all associated STUs.

2.3.3.1 Personal Computer Communication Services (PCCS) Module

Personal Computer Communication Services (PCCS) include videotex, teletext, personal computer service and electronic mail. These services can be provided by the RVDM through an optional component known as the PCCS module, which includes a moderately high speed and fully compatible communications controller as well as a videographic display function. One RVDM setup appropriate for residential users is equipped with two or more PCCS modules, which are shared on a demand assigned basis among sixteen STUs. The number and type of PCCS modules can be varied as functions of user traffic and demand, thereby allowing lower startup costs. The PCCS module provides alphamosaic

teletext and videotex, applications software and electronic mail. It also can contain video games software. An enhanced module can be configured to provide improved alphageometric graphics and increased memory capacity (up to 640K per household).

Low costs are possible because the central processing unit (CPU), random access memory (RAM), operating systems and applications software are all located within the RVDM rather than the STU. This allows for the sharing of computing facilities and their costs among the STUs connected to the RVDM. The remote location of computing facilities also provides for software copyright and file security, because with the use of passcards or authorization codes, each user will be permitted to download only specified operating systems, programs, files, etc. Shared resources allow the user to access personal computing facilities by purchasing only a lowcost keyboard and a monitor or regular TV set. There is no requirement for personal computers in the home, although users with their own personal computers can still access PCCS via any RS232C compatible link to the STU. Under these conditions, residential penetration of PCCS is likely to be high in the Smart Subdivision, because the only costs borne by the household are those for a keyboard, monitor or television set, and timed operator charges for use of the facilities.

2.3.3.2 Receiver Video Channel Converter (RVCC) Module

In addition to the PCCS modules, the RVDM can accommodate up to thirty-two Receiver Video Channel Converter (RVCC) modules. This enables full video service for an average of two different but simultaneous television signals for each home. If a particular household requires service for more than two simultaneous TV signals, it is also possible to accomodate this need.

The RVCC module performs the same functions as a separate set-top converter which is used currently by many cable TV operators to descramble pay TV channels. However, its remote location and inaccessibility to the user preclude the possibility

of signal "pirating", because only authorized channels are sent into the subscriber premises. This design enables the provision of a fully programmable video service with "impulse buying" capability on a pay-per-view basis, with no possibility of signal pirating.

2.3.4 Subscriber Terminal Unit (STU)

The IVDM™ unit located in the home is the Subscriber Terminal Unit (STU). Controlled by a single chip microprocessor, its principal role is to interface the home setting with the Smart Subdivision network. The STU polls a range of devices such as alarm detectors, utility meters and video service keypads. It can handle one or more telephone lines and a variety of circuit switched and polled data services. The STU constantly transmits a control message, which is usually idle, to the RVDM. By replacing the idle message with useful control information, the STU transfers user requests to the RVDM unit. The STU also undertakes its own maintenance routines.

The STU consists of a number of components. It is envisioned that a typical home would have a number of STU components conveniently located throughout. An internal home components STU is placed in the basement or utility area. It is used to control the home environment, read utility meters, and transmit fire, burglar, and other alarm messages. A general communications STU similarly located in the basement or utility area handles telephone and interactive data services. It can be packaged separately or in conjunction with the internal home components STU. An entertainment STU is located on or near the television set(s). It handles requests for cable television, high fidelity music, pay-per-view TV, and other entertainment services. The entertainment STU can respond to remote control devices such as video service keypads.

For users without their own PCs who wish to access PCCS or other computer services, the entertainment STU can be configured to accomodate this, as it is near the television set which acts

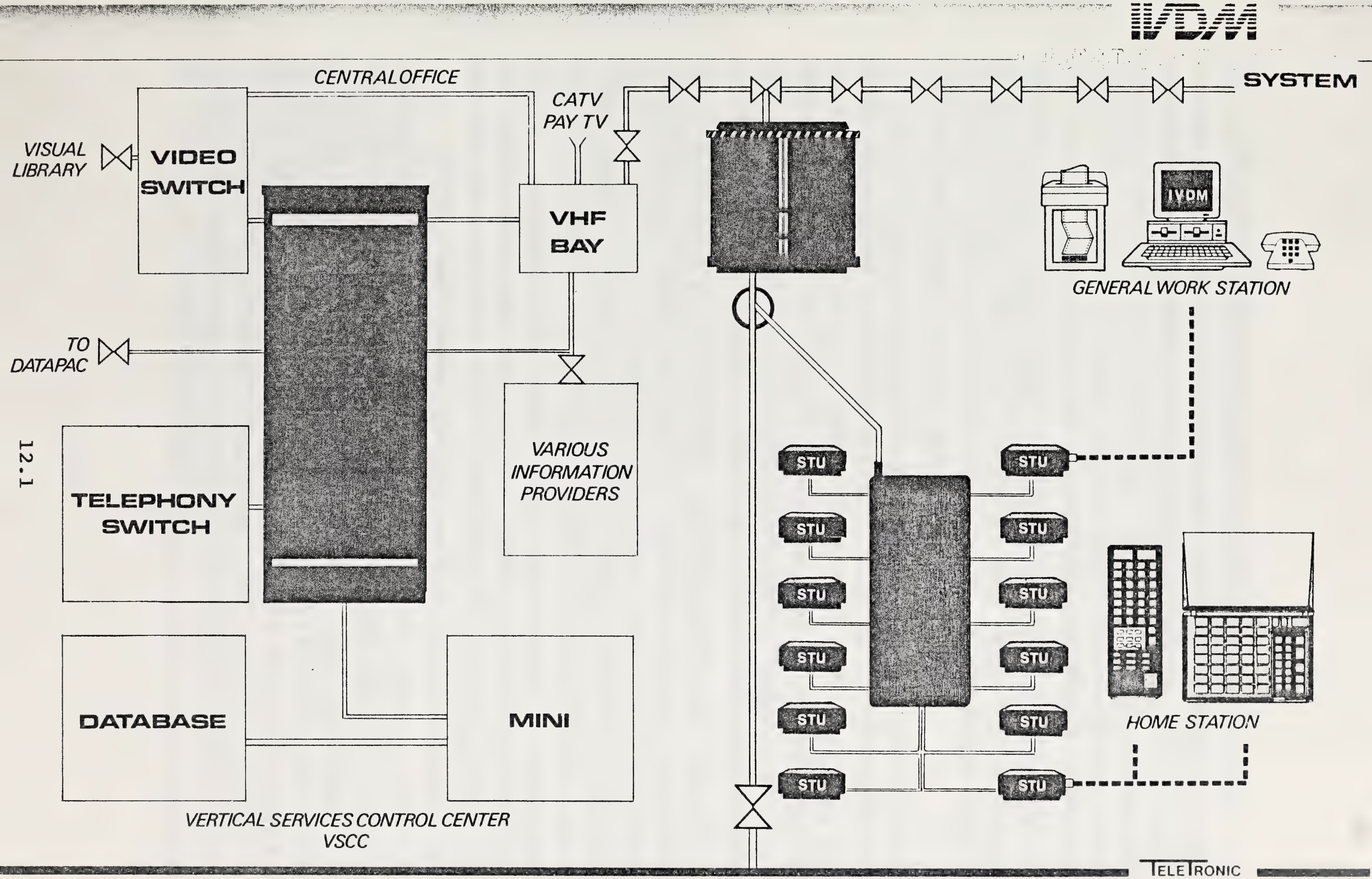


Figure A: IVDM System Block Diagram

as a monitor. The STU can also respond to wireless keyboards for even greater convenience. Users with their own PCs can access PCCS or other computer services via the general communications STU.

2.4 IVDM™: Flexible Architecture

There are many different ways to interconnect a hierarchical communications system such as IVDM™. In a star configuration, a "master" has direct connections to all its "slaves" via dedicated wires. The telephone system is such a network, where the central office is the master and the home telephone sets are the slaves. A bus architecture consists of a common wire to which each slave unit connects at a convenient point. A tree architecture is similar, but rather than consisting of one long line it branches into many divergent paths much like the branches of a tree. The conventional cable television system uses such an architecture.

In the Smart Subdivision, IVDM™ utilizes both connection methods for optimal advantage. In the most popular configuration of the RVDM-STU link, a star configuration is used. This assures privacy and the delivery of unique signals to each user. Connections between the RVDMs and the DCT through the IDTs generally use a bus or tree architecture. This saves on cabling costs because multiple RVDMs can share the same trunk cable. The judicious location of equipment within the hierarchy allows facilities to be shared and minimizes communication costs.

The flexible, intelligent IVDM™ architecture permits placement of switching nodes where they make the most economic and technical sense. The placement varies from application to application. For instance, in rural areas where the majority of telephone calls are between neighbours, local area calls are switched at the RVDM level in order to reduce trunk line traffic. By the same token, in residential areas where user density is high, switching nodes are more centrally located.

2.5 IVDM™ Solves the Noise Gathering Problem

Despite the fact that the upstream leg of coaxial cable television systems can provide additional revenue generating services, upstream noise gathering has plagued most attempts to implement two-way services. Due to their imperfect shielding, conventional cable television systems are susceptible to outside interference. This problem is compounded by the existence of powerful radio signals within the same frequency spectrum as upstream signals from subscribers' homes. These noise sources are inevitable and cannot be eliminated easily.

The principal difficulty with conventional cable TV systems in this respect is network design and layout. Since all subscribers connect to a common trunk, the system appears as one large party line. Upstream transmissions therefore must contend with the noise generated by the thousands of subscriber units sharing the line, as well as with any interference such as radio signals which enter the network through breaks in the cable. Consequently, experimental two-way signals have been swamped by so much noise that the head end receiver could not distinguish between the upstream signal and the noise. Unfortunately, this renders the upstream information path effectively useless.

The strength of the IVDM™ design is its inherent resistance to noise. It is made immune to noise by taking advantage of the fact that noise present at a particular regenerating unit is caused only by the subscriber units it directly controls. The hierarchical design of IVDM™ assures that any subunit controls only a small portion of the network, which results in low levels of noise gathering. Compared with the noise generated by thousands upon thousands of units in a conventional cable TV system, IVDM™ network components contend only with the noise of 32 or fewer lower level units. Also, IVDM™ network components contain digital circuitry capable of filtering out input noise for error-free signal regeneration.

2.6 IVDM™ System Reliability

The intelligent IVDM™ network makes a major contribution to system reliability. It extends the redundancy of conventional telephone systems to a broadband distribution network in order to assure a level of service at least as reliable as telephony. Moreover, every node in the System and the communication paths between them are monitored constantly. Any malfunction is reported to head end immediately. Repairs can be effected often before the user is even aware of the problem.

2.7 IVDM™ and Integrated Services Digital Network (ISDN)

The home telephone system employs a pair of twisted copper wires connecting the home to a central office exchange. It suffers from a restrictive bandwidth limitation. The telephone industry realizes this, and consequently there has been a push to implement an Integrated Services Digital Network (ISDN) solution which will replace the analog voice signals presently carried with a digital signal capable of carrying up to two simultaneous voice channels plus a data or control channel. This effectively solves the contention problem of the telephone network, but the drawback of ISDN over copper wire pairs is that its limited bandwidth does not support video other than slow scan techniques.

Nonetheless, because of the huge potential market, integrated circuit manufacturers are actively pursuing this design path, and within two to five years there promises to be a variety of integrated circuitry to implement low cost ISDN capable of supporting many of the low speed interactive services which IVDM™ delivers. Consequently, IVDM™ has been designed to maintain total compatibility with any copper pair implementation of ISDN and thus benefit from the same low cost integrated circuitry.

2.8 Compatibility and IVDM™

IVDM™ integrates easily with present day distribution technologies (telephone and cable TV), with forthcoming developments (ISDN), and with foreseen future developments (fibre optics). IVDM™ also interfaces with off-the-shelf RS232C compatible hardware, including any such devices capable of providing Smart House^{sm} services. IVDM™ supports all the above media. Through appropriate transceiver equipment, it also interfaces easily with microwave relay systems, satellite networks, and cellular radio technologies. Moreover, the System is based on both North American and international (CCITT) communications standards. Consequently, IVDM™ is a highly compatible and versatile communications system which can be implemented in virtually any residential setting.

3.0 SERVICES ENABLED BY IVDM™ TECHNOLOGY: A COMPARISON WITH ALTERNATIVE SYSTEMS

In the Smart Subdivision, IVDM™ can enhance the Smart House wiring arrangement and create the fully automated "Home of the Future". Not only can the STU home component interface with the Smart House^{sm} wiring system; it also can connect the household with the "Information Utility" provided by IVDM™ technology. The IVDM™ network can deliver a large number of high quality electronic services previously carried by separate networks. These services include cable TV, pay-per-view TV, telephone, computing services, videotex, electronic mail, home banking, home shopping, meter reading, load shedding and various alarm monitoring services, among others. As IVDM™ integrates all services over a single broadband facility, it is implemented more efficiently and cost effectively than conventional communication site servicing practices which duplicate home telephone and cable television systems. Perhaps more importantly though, services integration expands the scope and affordability of electronic services for home use and greatly improves the quality of residential life.

As IVDM™ is the first and only communication system to date which integrates all analog video and digital voice and data services over a single facility, it is not possible to compare the level and cost of services delivered by IVDM™ with those distributed over alternative broadband ISDN systems. Consequently, it is possible only to compare services in the IVDM™ configuration with those implemented over the telephone exchange and/or conventional one-way cable TV systems.

The following Network Comparison table shows that like the telephone system IVDM™ has two-way capabilities. However, twisted copper pairs suffer from a restrictive bandwidth limitation, even in an ISDN configuration (144 KHz). By utilizing broadband coaxial cable with a much higher information carrying capacity (450 MHz), IVDM™ overcomes the bandwidth limitations of the telephone system.

But unlike conventional cable TV systems, IVDM™ utilizes a flexible combination of switched star and tree and branch topologies. The System design also ensures that network components control no more than thirty two lower level nodes. This eliminates upstream noise ingress and enables the provision of voice, upstream, and two-way services previously unavailable in cable TV networks. Thus, IVDM™'s two-way, high bandwidth capacity represents a distinct improvement over conventional coaxial cable TV systems which are predominantly one-way. The resulting integration of all voice, video and data services over a single network is not possible with other presently available communication technologies.

As developments proceed in the field of fibre optics over the next fifteen to twenty years, it will be possible to implement ISDN over a transmission facility consisting entirely of optical fibres. With a bandwidth of 2 GHz, this will more than quadruple the already high information carrying capacity of IVDM™, enabling the provision of digitized TV for wide screen viewing. However, with what is presently known about fibre optics, the development of broadband optical fibre ISDN will be

Network Comparison

Transmission Medium			TWISTED PAIR		COAXIAL CABLE		FIBRE OPTICS (FO)	
Network			Telephone	ISDN	CATV	IVDM™	IVDM™	ISDN*
Topology			Star	Star	Branch/Tree	Combination	Combination	Combination
Voice		2 Way	analog	digital	Not Available	digital	digital	digital
Video		1 Way	not enough bandwidth	not enough bandwidth	analog	analog	analog/digital	digital
Upstream Services	Alarms	1 Way	fair	good	unreliable (noise)	fast reliable response time	good	good
	Monitoring	1 Way	fair	good	poor (noise)	good	good	good
Interactive Services		2 Way	low speed 2400 bps	low speed 64 Kbps	poor (noise)	excellent 1.544 Mbps	excellent 1.544 Mbps	excellent
Bandwidth			300-2400Hz (low)	144 KHz (moderate)	450 MHz (high)	450 MHz (high)	450 MHz (high)	2 GHz (very high)
General Consideration			bandwidth limited	BW limited No Video	predominantly 1 way	2 way high BW	hybrid COAX/FO	very expensive

* Broadband ISDN implemented over fully optical fibre network available in approximately 15-20 years.

Table 1: Network Comparison

very expensive. Fortunately, IVDM™ supports a hybrid coaxial cable/optical fibre transmission facility. Although bandwidth does not increase with this configuration, a hybrid IVDM™ facility will provide an affordable transition to the fully optical fibre ISDN.

In a broadband coaxial cable configuration, the IVDM™ Smart Subdivision provides the home with a wide range of services over and above that provided by the conventional Smart House℠ wiring arrangement alone. The Smart Subdivision supports the following types of home electronic services:

(1) cable television, pay-per-view TV, digital stereo and other entertainment services;
(2) telephone, data processing and various other interactive data services; and,
(3) conventional electronic services enabled by Smart House technology, also including automated energy management, load shedding, remote meter reading and alarm monitoring services.

Although numerous, the services discussed here are by no means exhaustive. Since IVDM™ is a transparent, high capacity communications network with an open architecture, it is capable of distributing a virtually infinite variety of home communication and information services.

3.1 Regular Cable Television Services

Since cable television has become a basic feature of home life since its advent in the 1970s, many fail to appreciate the far reaching impact it has had on society. Up-to-date news reports and the latest entertainment and educational programming, made more available by cable TV's selection of seven to fifteen channels, have contributed significantly to increasing our awareness of the global community. This is particularly true in remote and rural areas where antennae reception is poor or impossible.

The IVDM™ Smart Subdivision enjoys access to an even greater number of programming networks now distributed by direct broadcast satellite systems. The majority of IVDM™'s bandwidth is dedicated to providing homes with thirty to fifty-two video channels. This represents a substantial improvement over present offerings.

IVDM™ has been designed with an awareness of the topology of urban and suburban cable television systems. The System can be implemented easily into the home environment by upgrading existing coaxial cable networks with IVDM™ intelligent switching nodes. Once implemented, it distributes regular broadcast television as is normally done in conventional cable TV systems. The head end pickup can be any standard microwave or satellite reception network. The average cost for standard cable television is $10 - $15 per month. These costs are comparable with expected costs in the Smart Subdivision, but the household has access to a far greater number of channels.

3.2 Regular Pay Television Services

Conventional pay television services provide home viewers with access to reserved television channels which offer specialized or premium programming for an extra, flat monthly fee. However, with conventional one-way cable TV systems it has proven difficult to balance the fees charged for pay TV services, the number of subscribers and the quality of programming available. Subscribers often experience dissatisfaction with the programming quality and tend to drop the service, which results in a large churn rate adding extra cost for billing and service charges for connection and disconnection. Consequently, pay TV services average slightly more than $16 per month per channel. This compares unfavourably with the expected monthly rate of $10 per channel in an IVDM™ Smart Subdivision. The reason for this is clear.

In the two-way IVDM™ System, it is possible to monitor subscriber usage of pay television services and charge only for the amount of time actually viewed by the subscriber. This capability can change the operation of conventional pay TV services and thus broaden the audience sufficiently to justify higher quality programming. Under this scenario, it is likely that pay TV service providers will be induced to offer diverse programming on more channels. Only the viewing audience would pay for particular showings, and the unique programming offered could be billed at premium rates. Using the System's polling capabilities (see section 3.12), pay TV program producers can statistically analyze audience response in order to optimize the program mix and billing schedules.

In the IVDM™ Smart Subdivision, any video channel may be allocated as a pay TV channel and charged to subscribers on a flat rate basis as is conventionally done. Yet a principal advantage of IVDM™ over conventional pay TV schemes is that the channel convertor is located within the RVDM, away from the subscriber's premises. This eliminates the possibility of signal piracy and obviates the need for home descramblers, which range in price from $150 to $300. Each RVDM is shared among sixteen STUs, which substantially reduces the per subscriber cost of the convertor. The convertor functions of the RVDM unit are controlled by the Smart Subdivision central office. This enables remote connect/disconnect by a simple keyboard command at the central office or head end. Thus, overall costs to the subscriber are likely to be significantly less than with conventional pay TV systems.

3.3 Pay-Per-View (PPV) Television Service

Pay-per-view television is an extension of regular pay TV service. It offers premium programs such as first run movies which have been released from the box office circuit but which are not yet available from video cassette rental (VCR) outlets or on regular pay TV channels. Pay-per-view TV differs from regular

pay TV in that it emphasizes individual programs rather than long term service contracts. Thus, PPV represents a new premium tier in television entertainment programming.

Under an "impulse purchase" scenario, home viewers are able to request access to a particular program for a fixed fee. Without two-way capability inherent in the IVDM™ network, pay-per-view TV must be implemented over a so-called "hybrid" system, such as that offered in some U.S. localities. In this system subscribers make PPV requests over dedicated telephone lines. They dial a special number, identify themselves either to an operator or by a unique identity code input into the receiver, and then make their requests. Unfortunately, a hybrid reservation service is subject to overload at peak request times. Consequently, many subscribers encounter "busy" lines and hence are unable to make a request before a PPV program begins. This often irritates prospective viewers and dampens the very important "impulse" viewing segment of the market.

The IVDM™ Smart Subdivision offers a much more convenient method to access PPV service. Subscriber identity is provided automatically by the STU, and requests are made via a remote control keypad used to select normal television channels. The ease of operation makes the PPV service more convenient and hence is likely to induce a larger viewing audience.

IVDM™'s high performance upstream response allows the residential subscriber to select a program before it starts, without the inconveniences of the hybrid system approach. The DCT communicates with the central computing complex (CCC) at the head end which is programmed to track and monitor all television signal traffic to each home. When the subscriber selects a PPV channel with the remote control keypad, a menu appears on the TV screen and prompts the subscriber to choose from a selection of movies, sports events, concerts, etc. The cost for each also appears on the PPV menu. The subscriber makes a choice, and the CCC automatically gives the command to the DCT to switch the correct video signal to that particular subscriber. The computer

records the choice made, which subscriber made the selection, and when the selection was made. It also records when viewing is terminated and sends prorated billing information to the accounting department in the central office. This allows the subscriber to discontinue a particular viewing and pay only for the amount of time actually viewed, with no risk of being charged in full.

Subscribers may have access to this service for a flat rate charge if desired. Otherwise, the RVDM is instructed to prevent access to that channel. Subscriber use of authorization access codes allows restricted use to different individuals in the same home. As pay-per-view TV services presently are unavailable in Canada, it is not possible to compare their costs with those expected in an IVDM™ Smart Subdivision. A flat rate (suggested at $5.00 per month per channel) plus a per view fee (suggested as varying from $0.25 - $5.00 per use) can be charged automatically by the service provider's control or central office computer. The DCT in the Smart Subdivision office will direct the per use traffic information accordingly. Table 2 (see p. 37) compares subscriber costs for standard cable TV, pay TV, and pay-per-view TV in the Smart Subdivision with those in conventional service frameworks.

3.4 Narrowcast Television

Under a scenario similar to PPV TV, hobby enthusiasts and special interest groups in the Smart Subdivision will be able to request films from video library services such as school boards, public libraries, the National Film Board or private corporations. Through special video equipment at the central office, the service provider transmits the requested film to the DCT which directs the video feed to all subscribers who have requested that particular service connection. The RVDM is informed of the video request and makes the final connection through to the STU. Subscribers are appropriately charged each time they utilize the service.

3.5 Video Library Service

The DCT at the central office can be programmed to control access to a video library (e.g. an electronic VCR service), which may be located on site or remote from the central office. This service is implemented over the IVDM™ network in a manner similar to the pay-per-view feature. Instead of users having to make a special trip to rent a film from a video rental outlet, they simply make a request through the STU keypad or keyboard. A menu appears on the television screen and prompts the user to make a selection, which is relayed to the RVDM and on to the DCT at the central office. The DCT then sets up the appropriate video path to the requesting STU. All billing and control functions are handled in a manner similar to the pay-per-view feature.

3.6 Video Games

In the IVDM™ Smart Subdivision, the user can send a command to the DCT in the central office requesting access to a video game service. This can be implemented easily by a service provider in a fashion similar to the video library service. If the STU is authorized for that particular service, the video game service provider will send a video game menu to the DCT, which relays the information to the STU and prompts the subscriber to make a selection with the STU keypad or keyboard. The charge for access to this service could be a flat rate (suggested $1 per month) for downloading the games plus a usage charge (suggested $0.25 per half hour). Alternatively, video games software can be provided with the PCCS module in the RVDM unit and paid for on a timed use basis.

3.7 Digital Stereo

Standard audio or radio is distributed as on a conventional cable TV system. Wired music can be implemented easily and distributed economically to Smart Subdivision residents. The advantage of digital stereo over conventional analog reception is that the signal quality is far superior and subject to far less

interference. In a fashion similar to the electronic video library, the service provider can give home listeners access to a compact disc musical library containing a wide variety of programming selections to suit different tastes. This can be charged on a pay-per-use basis and automatically billed to subscribing listeners.

3.8 Telephone Service (Digital Telephony)

IVDM™ provides a distributed approach to telephone services in the Smart Subdivision. Telephone service is not necessarily an "add-on" feature of IVDM™ but rather a driving force in its design. Digital telephony modernizes a key telecommunication service in the home. Digital implementation means that signal quality is greatly improved, especially in long distance conversations. Distributed intelligent IVDM™ switching nodes permit lower cost access to popular telephone features such as interextension intercom, call waiting, call forwarding and calling party identification. Digital telephone service is integrated with simultaneous data communications, a most useful feature for residential users wishing to access PCCS or other data services without tying up voice channels. Effective sharing of the available communications bandwidth and internal computing power results in lower telephone service costs.

In order to meet the high standards of reliability required for telephone service, the IVDM™ design employs the same techniques of redundancy and continuous self-diagnostics used in central office switching equipment. Distributed intelligence extends reliability features to encompass both user and distribution equipment as well as the communications paths. Faults can be detected as they occur and usually can be repaired before the user is even aware of the problem. This represents a distinct improvement over conventional analog telephone service, where the user recognizes the fault when attempting to use the service and where the telephone company can effect repair only after notification by frequently irate customers.

Distributed intelligent switching nodes also permit direct communication paths between neighbours within the same Smart Subdivision network. This means that calls between neighbours do not tie up the trunk lines connecting the DCT to the public telephone exchange. This feature is particularly beneficial for rural and remote areas where a large proportion of calls are made between neighbours.

The IVDM™ Smart Subdivision provides digital telephony directly to the home. All standard telephone features are provided by the STU. The STU receives analog voice from the telephone set and converts it to a digital signal which is encoded onto the North American standard T-1 telephone line (or CCITT standard equivalent) appearing at each home. The T-1 line then transmits the encoded voice via the RVDM and IDT to the DCT in the central office for relay to the public telephone exchange.

At the central office the DCT connects the T-1 line to the digital or analog telephone switching exchange where it is interfaced to the public telephone network. If the public telephone exchange is a digital network, one switching stage is eliminated because the signal is already digital, thereby generating significant cost savings. Digital telephone service is expected to cost Smart Subdivision residents no more than $10 per month per line, which compares favourably to the standard cost of $12 per month per line for conventional analog service.

3.9 Data Communication Services

The IVDM™ Smart Subdivision offers three types of data communication services - circuit switched, polled packet and high-speed packet. While high-speed packet data communications (at 1.544 or 2.048 MBS) are most appropriate for commercial, institutional and industrial applications, circuit switched and polled packet data services are highly useful in the Smart Subdivision. Circuit switched data service is used for moderate-speed computer-to-computer communications involving, for instance, residential users wanting to interconnect home

computing facilities with those in local or remote locations. Polled packet data channels are used for two-way services involving upstream transmissions of relatively short messages, such as on-line database access, pay-per-view TV requests, videotex, teleshopping, telebanking and other interactive data services.

The quality and speed of data services enabled by IVDM™ technology in the Smart Subdivision is a distinct improvement relative to data services accommodated over the conventional telephone system. With an analog telephone link to the home, users must purchase a modem (at a cost of $500 - $600) which converts digital data signals into analog form suitable for transmission over the analog portion of the voice network. The converted signals are subject to noise and other interferences which manifest themselves as data errors. Moreover, because the telephone network has been designed for relatively short voice conversations as opposed to longer data sessions, the telephone company charges a high premium for the use of data channels.

IVDM™ technology enables data communications without the requirement of a modem. The data service user can obtain circuits with data transmission rates much higher than those available through the public data network, which can accommodate only low speed transmissions (up to 2400 baud). The IVDM™ network transmits data at rates which are four to six hundred times faster. Moreover, IVDM™ features controlled access to all data services, which enables the service provider to charge the user according to the level of service requested.

3.10 Personal Computer Communication Services (PCCS)

It is clear that the Home of the Future will need computing power for educational, business and recreational purposes. The question which naturally arises is how to supply it. Although every home conceivably can be equipped with a personal computer, the high costs of purchasing a PC (ranging from $450 - $3500) is

prohibitive in most cases. Moreover, many people are reluctant to purchase operating programs and applications software which are being improved upon on an almost daily basis.

The IVDM™ Smart Subdivision offers an alternative approach which permits the sharing of computer resources and thus lowers their per household costs. This approach is modular, which enables the network operator to upgrade the system with the continuing improvements in personal computer technologies, operating systems and applications software. Consequently, the Smart Subdivision resident has access to computing resources at far less cost and without fear of obsolescence. Effectively, all the user needs is a keyboard and a monitor or standard television.

The rationale behind Personal Computer and Communication Services (PCCS) is that many users can share a common powerful computer system. Computing resources are placed in the IVDM™ hierarchy where they are needed to link users to the resource in the most cost effective and efficient manner. Neither hardware nor software are purchased by the residential user; rather, they are paid for on a timed, per use basis.

The IVDM™-PCCS modules which contain the data processing and memory units are located within the RVDM unit, remote from the STU. This creates two significant functional and economic benefits for home computer use: universality and software copyright protection. Universality of service is provided by the operating system which is modular and located in the RVDM. This allows users to access several different operating systems by changing the command at the terminal. This results in a universal terminal that can be used to access several different operating systems of user choice.

Copyright protection of software also is provided by locating the RAM apart from the STU. This allows the RVDM unit to prevent programs and information from downloading to the STU. Thus, when programs are downloaded from a control database into

the RVDM memory units, they can be restricted from further transmission to the STU if they are to be copyright secured. Even though the STU has access to the program and data from its keyboard and screen, printing or copying onto a disk can be prevented for those programs and operating systems that are to be so restricted.

The PCCS module is configured to provide various levels of computing power (up to 640K memory capacity). Two or more CPUs, each equipped with its own RAM, are located in the RVDM, and the CPUs can be shared among groups of sixteen terminals. Thus a shared use arrangement between sixteen terminals and two to sixteen CPUs can be achieved.

A 8:1 shared use ratio allows for minimal cost consumer access to 320K home computing capability. The only equipment required in the home would be a regular television set or monitor (estimated to cost $125) and a "dumb" keyboard (estimated to cost $75). PCCS could be provided at an estimated cost of $3 per month plus $0.25 per hour to the user. Users would then have the same capability as with a typical stand-alone personal computer, but they could access an unlimited number of operating systems and application programs without purchasing the software. Users with their own personal computers could access PCCS at the STU via the standard RS232C connection on the keyboard. Table 2 (see p. 37) summarizes the cost savings of PCCS relative to stand-alone PC capability.

3.10.1 Electronic Mail

The PCCS module enables Smart Subdivision residents to transmit text or "electronic mail" from the keyboard to the STU. The STU transmits the data to the RVDM unit, where it is relayed to the DCT at the central office. The DCT in turn transmits the data to the appropriate network, such as MCI Mail or Gemgram, from which it is relayed to the head end at the receiving network. The head end then transmits the electronic message and displays the text on the receiving terminal or directs it to the

receiving database which serves as an "electronic mailbox". Messages to an address within the same network are facilitated internally.

Estimated user costs for this service are approximately $1.20 per month plus $0.02 for each nationally transmitted message and $0.12 for each internationally transmitted message. These costs are comparable with those of commercial electronic mail services. Electronic mail service offers Smart Subdivision residents a viable alternative to the often inefficient national postal system. IVDM™ can also distribute Telex services to residential users, providing yet another alternative to the conventional mail system.

3.10.2 Teletext

Teletext service allows the Smart Subdivision resident to access commonly asked for data such as that contained in public information directories. With this service, frames of information are continuously broadcast to subscribers over the lower frequency bands of the television signal spectrum. Upon engaging the teletext service, the subscriber specifies the type of information of interest. When this information appears at the subscriber unit, it is captured and displayed.

The advantage of such a service is that it can be implemented over a conventional one-way cable TV system. The service appears interactive (two-way) because subscribers can ask for the information that they receive. The disadvantage of teletext is that its nonspecific transmission restricts the amount of information that can be provided. This is attributable to the compromise which must be made between the amount of information carried and the length of time to retrieve it, as all the information is sent repeatedly in one long record. When users make a request for a particular frame of information at the terminal, they must wait until the record reaches the proper data. If the record is large the delay becomes unacceptably long, resulting in higher than necessary usage charges.

Recent teletext offerings such as the X-Press news retrieval service have overcome this disadvantage by interfacing with home PCs which continually monitor the incoming data record, updating and storing frames of information as they come. Unfortunately, not only does this scenario require a PC in the home, but it also precludes simultaneous use of the PC for any other purpose.

The IVDM™ shared computing resource arrangement overcomes this further constraint by allowing users to share a dedicated computing resource at head end which similarly updates and stores the incoming data record. Not only is the user spared from buying a personal computer or tying up an existing computer for this one purpose, but immediate access to frames of interest substantially reduces on-line time. The pay-per-use feature enabled by IVDM™ makes the service more flexible. Consequently, IVDM™ technology is likely to make teletext and similar services much more popular.

Information providers can supply their own teletext information library and access IVDM™ at the DCT in the Smart Subdivision central office. The subscriber engages the teletext service from the STU keypad or keyboard. The DCT monitors the charges, perhaps on a flat rate basis (suggested $2 per month) plus a charge for the time connected (suggested $0.05 per minute usage), and the central computer handles all billing functions on a pay-per-use basis. Although these usage rates are comparable with those of conventional teletext systems, by having immediate access to particular frames of interest the user is spared from unnecessarily lengthy on-line sessions. This effectively reduces subscriber charges.

3.10.3 Videotex

Unlike teletext, videotex is an interactive service which is normally delivered over the telephone system. It has the appearance of a teletext service in that the user requests information which is subsequently displayed in graphical form on a monitor or television screen. However, because the user

interacts with a remote computer rather than receiving a continuously broadcast signal, access to a database of any size is possible. Consequently, wider bodies of knowledge are accessible by videotex relative to the restricted amount of data available through teletext.

The IVDM™ Smart Subdivision provides an integrated two-way communications package ideally suited to distribute videotex for residential uses. Users enter their requests at the STU keypad, results are returned on the monitor or television screen, and the central computer charges only for the amount of time actually used. The high speed data capability of IVDM™ mitigates the slow transmission problems of the telephone system's data communication channels. As well, the sharing of graphics capabilities among a number of users further spreads the costs. These features are likely to make videotex services such as Telidon or The Source more popular, unlike previous commercial ventures such as NABU whose costs were driven to unacceptable levels by the high costs of dedicated user terminals.

Any videotex information provider can access IVDM™ at the central office through the DCT. The videotex service may be Telidon or any other videotex service such as CompuServe, InfoGlobe, Dow Jones News Retrieval, etc., without the requirement of dedicated user terminals (cost $500-1000) or communications software (cost approx. $250). The DCT monitors all user traffic and restricts access to those who have not subscribed. The usage cost could be a flat rate (suggested $3 per month) plus a timed charge for on-line access. This compares favourably with videotex services supplied via the telephone system, where on-line user charges soar because of slow data transmission.

3.11 Other Interactive Residential Data Services

IVDM™ is an organized data communications system which is modularly designed to allow microprocessor based equipment to interact. In the Smart Subdivision it serves as a telecommuni-

cations network for a broadband local area network (LAN) implementation. Since IVDM™ can interface with the public voice and data networks and with microwave relay systems and satellite communication networks, it can be utilized as a metropolitan area network (MAN) and as a wide area network (WAN).

In the Smart Subdivision networking is implemented over IVDM™ through the STU in the home. The STU is connected to either a "dumb" or "intelligent" terminal. The communication controller is the DCT. The user interface is the STU, and the software protocol is located in the RVDM memory units remote from the STU. This ensures secure communications.

The significance of IVDM™'s local, metropolitan and wide area network capabilities is that residential users can have access to such services as home banking, teleshopping and electronic community bulletin boards. Within the IVDM™ Smart Subdivision, it is possible for financial and retail organizations to form home teleservice consortia in cooperation with the central office so that residents can access teleshopping "menus" and banking networks from within their homes in a format similar to videotex. This can be achieved without the inconveniences of a "hybrid" system or the requirement of PCs and proprietary communications software in the home.

When made affordable to the typical residential consumer, such services can make life both safer and more convenient for the elderly, the disabled, students and two income earning families. As well, IVDM™'s network capabilities allow users to link their home computing facilities with those in educational, commercial and institutional organizations. This enables Smart Subdivision residents to interconnect their homes with schools and workplaces via PCCS or any personal computer. Such a scenario will make "telecommuting" a realistic prospect for the "Electronic Cottage" of the future.

3.12 Polling Services

Information providers and gatherers such as broadcast television networks and market research organizations can utilize the two-way capabilities of IVDM™ for conducting viewer opinion polling. Political programs and experimental entertainment programming where viewers have control of the plot are among the applications of this polling technique. Viewers can access opinion polling by the same remote control keypad used for television channel selection. This method is far more user convenient than polling via the telephone system, which is more expensive for the pollster and yet receives a notoriously low percentage of viewer response.

Home viewers tuned into the television poll may send their opinion to the STU from the keypad or the keyboard. The STU transmits the information to the DCT in the central office which directs the polled information to the central computer. The computer tabulates the opinions polled and within minutes sends the information to the pollster or researcher. Estimated cost to the pollster is $0.05 per poll per respondent, a significant savings over alternative polling techniques.

3.13 Smart House℠ Services

The basic component of the Smart House℠ is its wiring system. According to the Smart House Development Venture in Rockville, Maryland, initial designs of this advanced home wiring system call for a single cable which simultaneously distributes control and data signals, electrical power, and audio and video signals within the home. This is conceptually and technologically consistent with the IVDM™ approach. The Smart House wiring system will involve specially designed, multiple purpose outlets into which one can plug electrical appliances, telephones, televisions, smoke detectors, stereo speakers, personal computers, etc., without signal interference or overload. Plug and outlet adaptors are being developed to accommodate conventional home hardware. As well, the use of controllers to

regulate power flow to appliances and other electrical devices will substantially reduce shock and fire hazard. Thus, the development of the Smart House℠ wiring system represents a leap forward in modernizing home life.

Using a closed loop, decentralized microprocessor based arrangement, the Smart House℠ wiring system provides a number of automated home services, chief among which are various alarm and home security features, utility meter reading, environmental control and energy management, and home appliance regulation. However, the Smart Subdivision home enjoys a complete range of electronic services above and beyond that enabled by a Smart House wiring system alone. The STU facility does not only interface with the Smart House℠ wiring system; it also connects the household with the "Information Utility" provided by IVDM™ technology.

3.13.1 Residential Alarm Monitoring and Security Services

In the Smart Subdivision, home alarm services are merely one of many provided by IVDM™. Sharing the System among various services provides the home with security features comparable to very expensive commercial systems, at a fraction of the cost. When detecting an alarm, conventional residential security systems either sound a warning device (which is sometimes ignored) or have an automatic dialing unit which reports the alarm to the appropriate security service or public authority. The weak link in such a system is the use of the telephone network lines. Should the telephone line be cut or otherwise out-of-service, or should there be a failure at the telephone exchange central office, an alarm may never be reported.

The IVDM™ network improves substantially upon such a system by providing continuous line and equipment supervision. The communication link between the home and the central office equipment is always monitored, without the problem of contention. All residential units are periodically polled. A cut or broken

wire results in loss of this link and no answer to the poll, which is detected as a potential alarm and is relayed to the appropriate security service organization. This assures fast response time to potential and real alarm situations. Within the home, the STU can be configured to provide on-premises video security features.

Any type of alarm that can cause a change-of-state condition will be detected by the Subscriber Terminal Unit (STU). The STU instantaneously transmits the change-of-state condition and its corresponding address to the RVDM and then on to the Distribution Control Terminal (DCT) in the central office. The DCT interprets the alarm type and subscriber address and diverts the message to the appropriate security service organization or public safety agency which then takes the required action. Alarm types may include fire, burglar, medical, etc. In special circumstances, alarms can be custom equipped for the blind, the hearing disabled, the physically handicapped, and the elderly. Expected cost to the home is approximately $3-5 per alarm per month, a fraction of the cost for conventional alarm monitoring services.

3.13.2 Load Management Services

If connected to the Smart Subdivision network, utility companies can utilize the two-way capabilities of IVDM™ to monitor and regulate home energy consumption using time sensitive pricing techniques. The utility company can access the communications protocol in a particular home by instructing the central computing complex (CCC) to send a command to the DCT to control a valve or other such device at any authorized STU address. The DCT relays the information to the RVDM and on to the appropriate STU. The STU then transmits the command to the energy control relay within the STU, a unit ordinarily provided by the utility company. In this way utilities such as water, electricity, and gas can be connected, disconnected and otherwise controlled by the utility company. The operator's charge is estimated at $0.50 per month per control to the utility company.

This operational cost figure is comparable to load management implemented over the telephone system, and the capital costs of relays and interface equipment are virtually the same. However, the high bandwidth capacity of IVDM™ obviates the need for separate dedicated wire pairs.

The microprocessor based STU can also be programmed to automatically control the operation of home environmental systems such as heating, cooling, humidity and lighting. This can be implemented in accordance with the resident's particular time preferences. The STU can be programmed to regulate all home appliances as well. Although these features cannot be implemented over the telephone system, they can be achieved using a stand-alone PC with appropriate software. Unfortunately, the high costs of PCs and the necessary software make it prohibitively expensive for the average residential consumer.

3.13.3 Remote Meter Reading Service

The STU can be configured to monitor all meters in the vicinity of the home. When a utility company connected to the network makes a request to read a particular meter or group of meters, the DCT sends the command to the appropriate STU which then reads the monitoring device and transmits the information back to the utility company. This enables the utility company to implement time sensitive pricing techniques which residents can use to advantage in controlling their household energy costs. Expected cost to the utility company is approximately $0.75 per meter per month. Although the cost and level of this service implemented over the telephone system are virtually the same, contention is not a problem and no more than one telephone line is required.

Table 2

Service Comparisons

Service	Standard Coaxial System	IVDM™ System
Cable TV	$10-15/mo.(1)	$10-15/mo.
Pay TV	$16/ch/mo.(2)	$10/ch/mo.
PPV TV	not avail.	$0.25-5.00 ea.
Audio	$5-6/mo.(analog)	$5-6/mo.(digital)
	Twisted Copper Pair	IVDM™ System
Telephony	$12/mo.(3)	$10/mo.(3)
Videotex	Fee + terminal(4)(10)	$3/mo. + $.25/hr.
Load Mgt.	$.50/control/mo.(5)(11)	$.50/control/mo.(5)
Meter Reading	$.75/meter/mo.(5)(11)	$.75/meter/mo.
Alarm Monitoring	$10-15/alarm/mo.(5)(11)	$3-5/alarm/mo.
Computing services:	Stand-Alone	IVDM™ PCCS
IBM PC	$3500 (6)	$350 (7)
Apple II	$1200 (6)	$120 (7)
Commodore 64	$ 450 (6)	$ 45 (7)
Operating System	$50-250 ea.(6)	$3/mo + $.25/hr (6)
Appl'ns Software	$50-800 ea.(6)	incl. w/oper. sys.
Monitor & Keyboard	incl. w/PC	$200 (6)
Other Services:	Telco/CATV Systems	IVDM™ System
Narrowcast TV	not avail.	shared cost
Elec video service	not avail.	pay-per-use
Energy management	not avail.	no cost to home
Teletext	not avail.	$2/mo. + per-use fee
Electronic mail (8)	not avail.	$1.20/mo. + fee/message
Telex (8)	not avail.	Fee/mo. + usage charge
Video security	not avail.	video equip.(6)
Polling	$.50/resp.(9)	$.05/resp.(9)

Notes:

(1) 7 - 15 channels v. 30 - 52 channels with IVDM™.

(2) cost of descrambler = $150-300.

(3) IVDM™ provides digital telephone service.

(4) cost $500-1000; or PC with special card @ $200.

(5) IVDM™ does not require central interface equip @ $10-15 ea.

(6) costs borne by household user.

(7) costs (per STU) borne by network operator (excl. disk drive & printer).

(8) these services presently not available to households.

(9) IVDM™ more convenient, higher response rate than telco polling.

(10) accessed via telephone system (non-simultaneous with voice).

(11) separate twisted pair req'd for simultaneous voice.

4.0 A RESIDENTIAL IVDM™ MARKET TRIAL

4.1 Residential Community Plan

In order to demonstrate IVDM™'s advanced capabilities in an operational setting and generate local interest in the technology, TeleTronic Communications has developed a detailed installation plan for installing equipment and cable required to implement a Smart Subdivision trial for a representative Edmonton community. Involving a total of 4992 communication connections, this trial site community contains a normal range of single family homes, businesses and institutions. The network is comprised as follows:

(1) 4752 single family homes (4752 STU communication connections);

(2) 1 junior/composite high school (192 STU communication connections);

(3) 1 community shopping centre representing retail concerns such as a grocery store, a pharmacy, a dry cleaner, a convenience store, a bank branch office, etc. (24 STU communication connections); and,

(4) 1 complex of professional office suites representing a legal office, a medical office, a dental office, etc. (24 STU communication connections).

This model is intended to represent many residential subdivisions typical of the South Side and West End districts of the City where there is a sufficient number of consumers who have above average incomes and are thus likely to make frequent use of the advanced electronic services enabled by IVDM™ technology. This is an important consideration when selecting a market trial site.

In order to simplify the network, a rectangular array of 210 blocks is used. Of this, 198 blocks contain individual homes. There are 24 lots per block with one single family home per lot. Eight blocks are occupied by a junior/composite high school, one block by a community shopping centre, one block by a professional

office complex and the Smart Subdivision central office, and two blocks by a park. Figure 1 is a map of the community.

4.2 Network Design Considerations

A key telecommunication service provided by IVDM™ is digital telephony, both within the community and with the outside world. Among other functions, the DCT (Distribution Control Terminal) contains the standard North American T1 trunks interconnecting the Smart Subdivision with the telephone exchange. This is required to switch telephone calls to and from the surrounding area. Ideally, the probability of encountering trunk line congestion should be in the vicinity of .01, which corresponds to 18.7 erlangs of traffic per DCT. Assuming that each communication connection generates 0.1 erlang of traffic (3.6 ccs), 18.7 erlangs are generated by 187 connections. Consequently, this community of 4992 connections requires 28 DCT units, including a master DCT at the Smart Subdivision central office.

The community is thus divided into 28 areas with 9 - 12 RVDM (Remote Video and Data Multiplex) units in each. Each RVDM serves a maximum of 16 STUs (Subscriber Terminal Units). Each area also has its own IDT (Intermediate Distribution Terminal), which is used as a data regenerator.

4.2.1 <u>Trunk Cables</u>

The arrangement of trunk cables shown in Figure 2 was chosen to avoid the problem of too many line extender amplifiers in cascade. Compared with trunk amplifiers, line extender amplifiers operate with higher gain and output in order to compensate for the loss of the subscriber taps and smaller cable. This increases the distortion and limits the number of amplifiers through which the signals may pass. With this arrangement, the greatest number of line extenders in cascade is two.

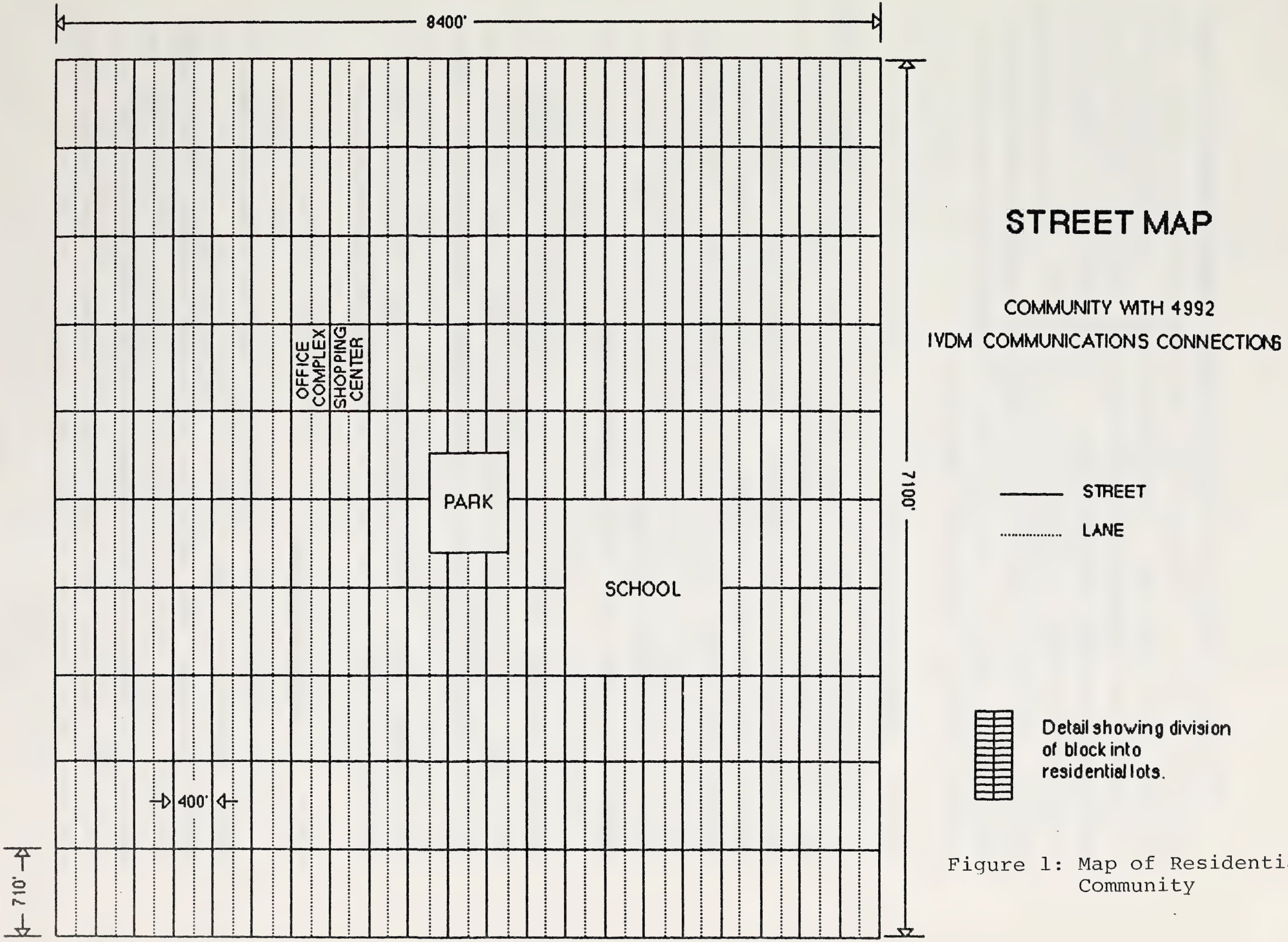


Figure 1: Map of Residential Community

The two commonly used bidirectional cable systems are known as sub-split (5 - 30 MHz and 54 - 450 MHz) and mid-split (5 - 108 MHz and 174 - 450 MHz). The lower band of frequencies is used for upstream transmission, and the upper band of frequencies is used for downstream transmissions. With IVDM™, each of the eight long trunk cables is shared by three IDTs. Since each IDT requires 12 MHz of bandwidth for upstream signals, the mid-split approach is used in order to pass the upstream signals which occupy a total of 36 MHz of bandwidth.

4.2.2 Downstream Design

As signals proceed along a cable, they become weaker. If no amplifiers were used, the signals at the receiving end would be so distorted with interference and noise that the television picture would be very degraded. The downstream design problem is locating amplifiers so that the subscriber views a clear picture, hears high fidelity music and receives data without errors. These requirements are satisfied if the subscriber receives a television signal of 2 millivolts or more.

Figure 2 is a diagram showing all the cables and amplifiers in the system. The amplifiers are located so that each subscriber receives a television signal of at least 2 millivolts. In cable systems it is much more convenient to use levels instead of voltages. The level, in decibels relative to 1 millivolt (abbreviated dBmV), is the logarithm of the number of millivolts multiplied by 20. A few levels are shown in Figure 2.

4.2.3 Upstream Design

Lower frequencies are used for the upstream signals, and cable losses are less. Some of the longest runs have been checked to ensure that amplifier gains are adequate. The signals arriving at an IDT from all associated RVDMs must be at the same level. This makes it necessary to adjust the output levels of the RVDMs as well as the gains of some of the amplifiers. Following is a list of the network parameters.

4.2.4 Network Parameters

Trunk Cable Loss

1 dB/100 ft. (ch. 13)

.3 dB/100 ft. (20 MHz)

Feeder Cable Loss

2 dB/100 ft. (ch. 13)

.6 dB/100 ft. (20 MHz)

Drop Cable Loss

2.4 dB/100 ft. (ch. 2)

Other losses used:

Splitter 3.5 dB

Four way splitter 7 dB

IDT filters 4 dB

RVDM directional couplers

coupling loss 9 dB

insertion loss 1.2 dB

Trunk Amplifier Levels (Downstream)

Input 7 dBmV

Maximum output 32 dBmV

Maximum feeder Output 47 dBmV

Trunk Amplifier Levels (Upstream)

Input 33 dBmV

Feeder input 33 dBmV

Maximum output 50 dBmV

Line Extender Levels (Downstream)

Input 22 dBmV

Maximum output 50 dBmV

Line Extender Levels (Upstream)

Input 24 dBmV

Maximum output 50 dBmV

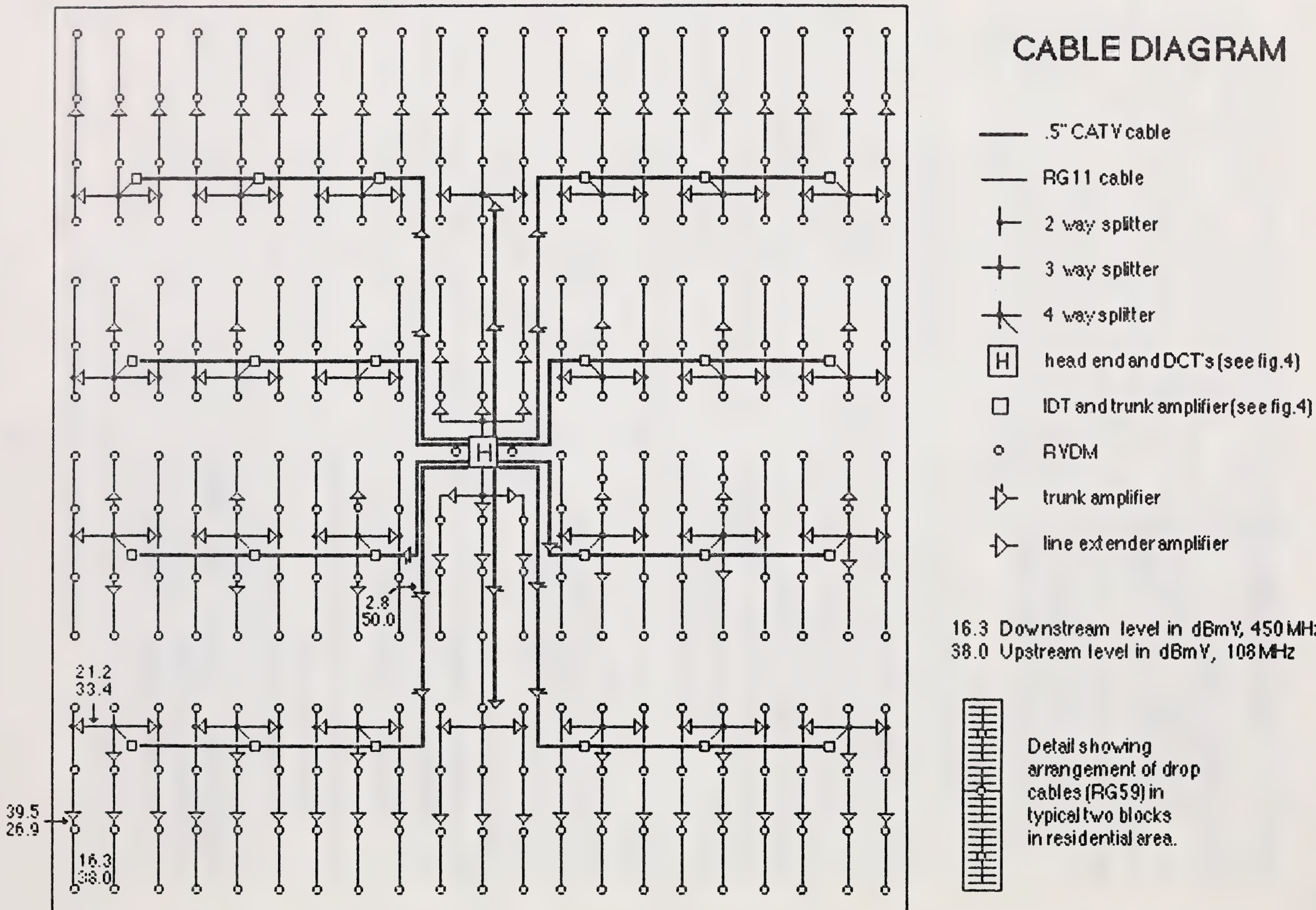


Figure 2: Cable Diagram

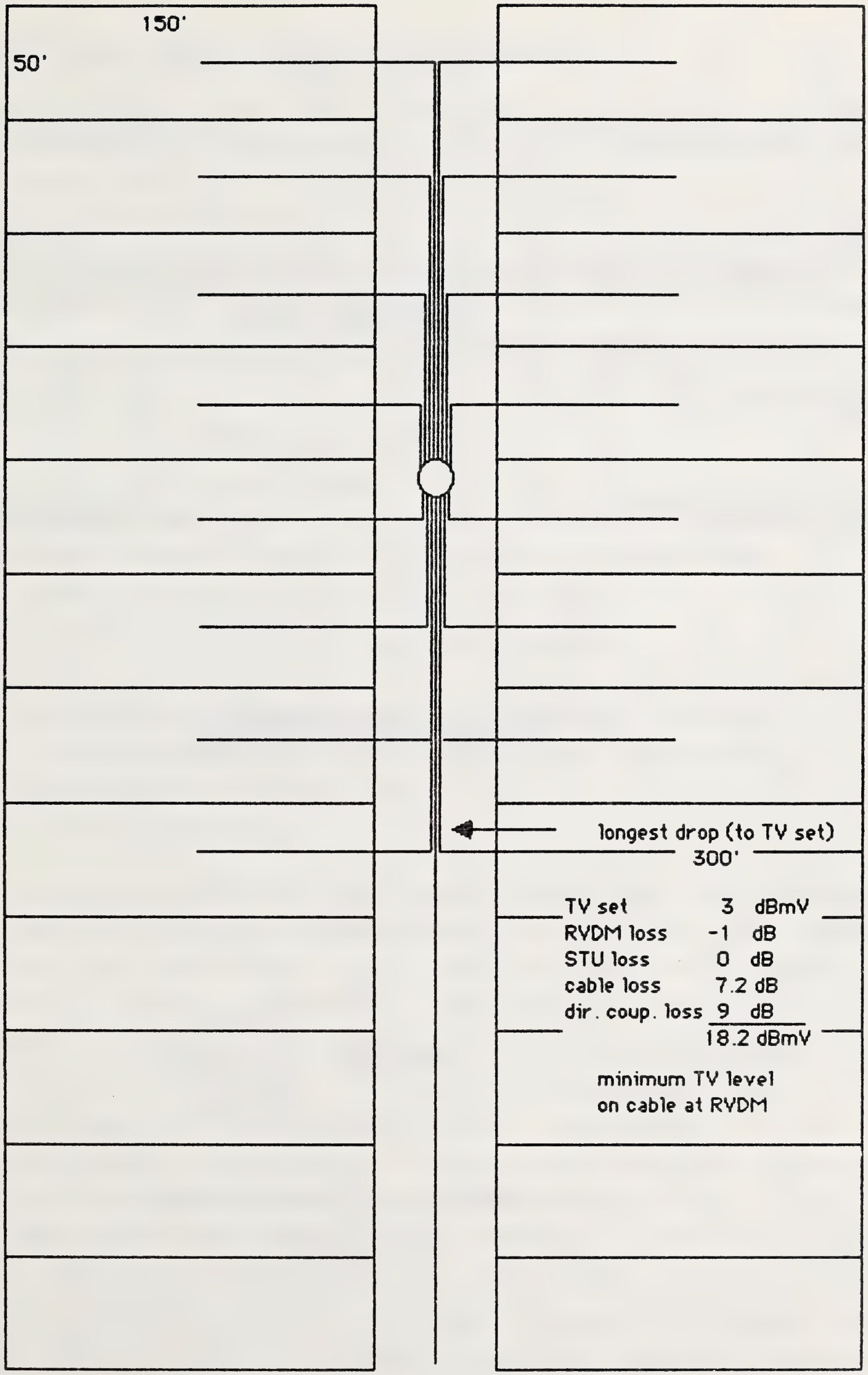
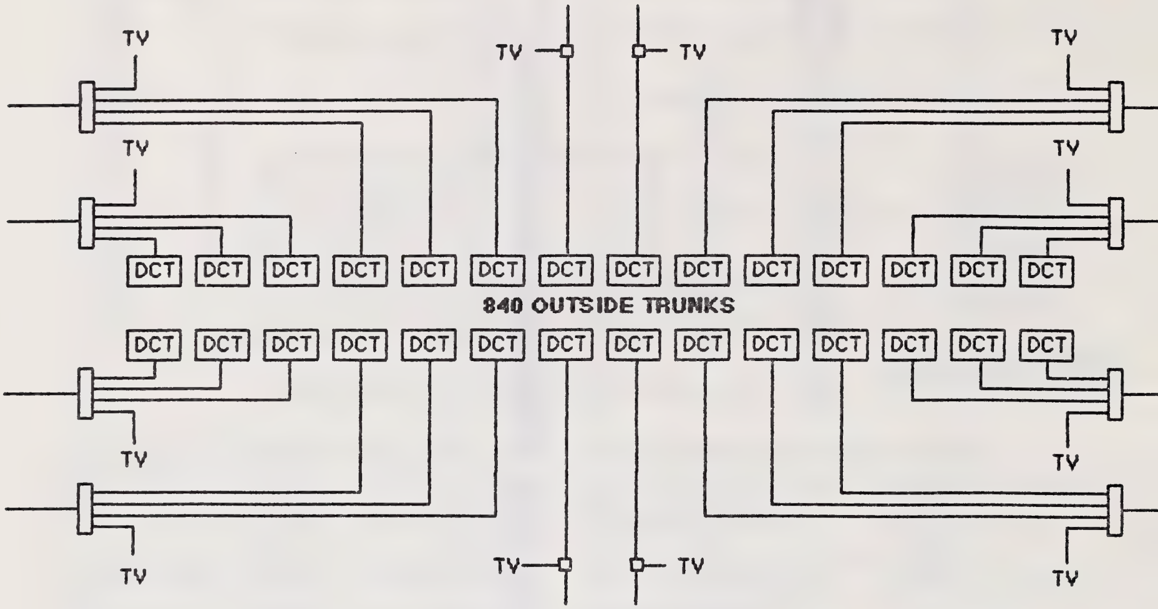
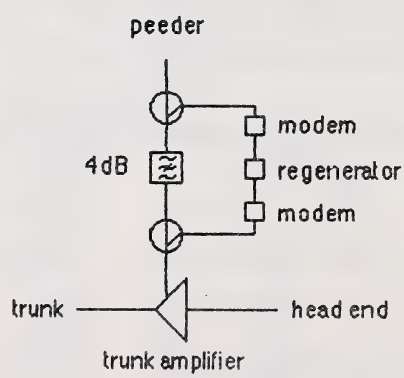


Figure 3: Subscriber Drop Cables

SUBSCRIBER DROP CABLES, RESIDENTIAL AREA



HEAD END DETAIL



IDT DETAIL

Figure 4: Head End/IDT Details

4.3 IVDM™ System Requirements: Cost Estimates

IVDM™ technology can provide the Smart Subdivision resident with a virtually limitless variety of electronic and entertainment services. However, TeleTronic does not expect the trial network to be equipped for all the services described in section 3.0. For the purpose of cost estimation, it is assumed that each home or other user premises has access to the following services:

(a) automated meter readings for water, electricity and gas, plus load management;
(b) fire alarm monitoring;
(c) digital telephone service;
(d) 30-52 channel regular cable and pay television;
(e) demand access pay-per-view television;
(f) videotex and on-line database access;
(g) PCCS personal computer service (320 K RAM with alphamosaic graphics and 2-3 operating systems);
(h) energy management and home appliance regulation;
(i) digitized FM stereo; and,
(j) opinion polling.

It is assumed that the Smart Subdivision trial will managed and operated by a consortium consisting of TeleTronic, the system buyer, service providers and other participants such as regulators. Most of the services to be offered can be implemented by interfacing IVDM™ with existing programming and service networks: telephony - "edmonton telephones"; cable TV - Shaw Cable/Quality Cable Television; telemetry - City of Edmonton/Northwestern Utilities; videotex and on-line database access - Telidon, The Globe and Mail On-line, etc.; digital stereo - any number of local radio stations or those already carried by the local cable operator. This makes it economically feasible to provide services with user threshholds higher than the trial community of 5000 connections can otherwise support. However, services like pay-per-view TV, personal computer communication service and opinion polling are either in their

infancy or are not yet available, and very little is known about user threshholds required to implement them economically on a large scale. Market analysis of services under a trial offering will reveal user demand patterns and thus enable the service providers to make inferences regarding operational threshholds for these new services. Indeed, one objective of the Smart Subdivision trial is to conduct user analysis tests and statistically evaluate the residential market for new electronic media.

With an IVDM™ network equipped to deliver this service mix to 4992 communication connections, the total cost per STU connection is estimated to be $ 1123. This includes the cost of installing the STUs as well as the telemetry equipment and valve control relays (to be provided by the local utility company). It is assumed that the homes in this subdivision are recent builds and have been equipped with a Smart House℠ wiring system.

The installation cost is based on the Smart House℠ concept wherein all communication wiring has been built into the house with the electric power wiring. With a conventionally wired house, the installation cost is approximately 40% higher. This estimate is based upon the projected cost savings to be realized by combining all electronic wiring into integrated systems for Intelligent Buildings (Business Week, June 24, 1985). It is assumed that the home already has a television, a touch-tone telephone and 2 smoke/heat detectors. The non-residential locations are also assumed to have existing telephone systems and smoke/heat detectors.

Each RVDM (or IDT) contains the hardware and software components required to implement demand access services (such as pay-per-view TV) and PCCS, and each STU is similarly equipped to provide on-site energy management and appliance regulation. The homeowner would bear the cost of obtaining a keyboard required to access PCCS (at a cost of approximately $75) plus any optional hardware such as a disk drive or printer. His or her television set can act as a video monitor, or a dedicated monitor can be

purchased for as little as $125. User terminals and other related hardware are also purchased separately in non-residential locations. Users with their own personal computers can access PCCS via the STU and the standard RS-232C connection on the keyboard.

When implemented over coaxial cable, IVDM™'s two-way capabilities provide a level of service superior to that of so-called "hybrid systems" - a combination of the conventional one-way cable TV system and the telephone network. In order to provide a basic level of data services in the alternative hybrid system, the local loop of the telephone exchange must first be upgraded with a packet switching system, at a cost of approximately $ 650 per subscriber (Yankee Group estimate, 1984). This includes data modulation equipment at the subscribers' premises, multiplexing and protocol conversion equipment at the telephone exchange central office, and packet switching processors.

Similarly, in order to provide simultaneous voice and data services, at least one additional twisted pair connection must be installed at each user premises, at an approximate cost of $ 133 per STU. As well, in order to provide demand access services such as pay-per-view TV, addressable convertors must also be installed at each subscriber location, at a cost of $ 250 each. This is required to reduce telephone trunk line congestion during peak request times, often a problem with dial-up service. Including meter readers and utility control relays to be installed by the local utility company at each user location, the total cost of implementing this hybrid configuration rather than IVDM™ is estimated at $ 5.61 million.

If IVDM™ is implemented over the existing coaxial cable TV system, it is not necessary to upgrade the local loop of the telephone network. In fact, the twisted pair connections are rendered not only obsolete but also useless, as IVDM™ carries all voice and data services in addition to video. It likely will be necessary to replace some of the coaxial cable, upgrade the amplifiers for 2-way transmissions and install a computer and

related equipment in the Smart Subdivision central office. Using differential analysis, total estimated costs for IVDM™ relative to the hybrid alternative are detailed in Table 3.

Table 3
IVDM v. Hybrid System Cost Estimates

	IVDM™		Hybrid System
4992 STUs (@ $500 ea.)	$ 2,496,000		---
314 RVDMs (@ $6000 ea.)	1,884,000		---
24 IDTs (@ $3000 ea.)	72,000		---
28 DCTs (@ $9000 ea.)	252,000		---
Coaxial cable replacement	18,750	(1)	---
Upgrade amplifiers for 2-way	10,800		---
Central Office computer & equip.	50,000		---
TOTAL IVDM™ EQUIP. COST	4,783,550	(2)	---
STU installation (@ $75 ea.)	374,400		---
TOTAL IVDM™ INSTALLED COST	5,157,950	(3)	---
Util. Co. equip. cost (@ $90/drop)	449,280	(4)	$ 449,280
Packet switch upgrade (@ $650/drop)	---		3,244,800
Addressable convertors (@ $250 ea.)	---		1,248,000
Add'l twisted pair connections (5)	---		665,340
GRAND TOTALS (6)	$ 5,607,230		$ 5,607,420

Notes:

(1) 30% replacement assumed.
(2) or $ 958 per drop.
(3) or $ 1033 per drop.
(4) non-differential cost.
(5) required for simultaneous voice and data, @ $ approx. $ 133 per drop, installed.
(6) or $ 1123 per drop for either scenario.

IVDM™ is compared to the hybrid system because there exists no alternative broadband ISDN (Integrated Services Digital Network) which offers the service features and capabilities of IVDM™. In differential terms, IVDM™ can be implemented for the same cost as maintaining separate networks and upgrading the telephone exchange local loop. Yet for several reasons IVDM™ is superior to the hybrid system:

(1) More services are distributed over a single transmission facility, which makes each service less expensive to operate;
(2) The channel capacity available for data services is hundreds of times greater;
(3) Every node and cable is continuously monitored so that a failure in the subscriber's equipment or loop is detected immediately;
(4) Opinion polling responses are more convenient and efficient with IVDM™ and are likely to generate higher response rates relative to dialed-in voice response;
(5) Other services such as electronic mail and narrowcast TV, as well as upgrades to PCCS operating systems and applications software, are easily added with the modular IVDM™ System;
(6) Pay-per-view program selections are more efficient with IVDM™ compared to addressable convertor identification, which is still subject to possible trunk line congestion during peak request times;
(7) Digital telephone service is provided directly to the user location, which modernizes and even reduces the cost of this key telecommunication service;
(8) Telephone calls between neighbours are handled more efficiently because they are switched at the RVDM and/or IDT level and do not pass through the central office;
(9) The hybrid system cannot provide shared PC capability.

4.4 Non-residential Uses of IVDM™ Technology

Commercial and educational users in the Smart Subdivision are assumed to have access to the same services as households, with the exception of entertainment television. The local professional offices, bank branch offices and retail stores would find IVDM™'s energy management, digital telecommunications and personal computing services (word processing, accounting software, spreadsheets, etc.) to be particularly useful in their

operations. IVDM™ will also enable them to interconnect with various suppliers and/or head offices. As well, IVDM™ will offer non-residential users advanced "Intelligent Building" features, an approach consistent with the Smart Subdivision concept.

5.0 BENEFITS OF APPLYING IVDM™ TECHNOLOGY IN ALBERTA

The development and application of IVDM™ technology in Alberta will yield considerable benefits. This is true for residential as well as other uses of the technology. Its implementation will contribute to improving the quality of home life, will reduce the cost of residential site servicing and will generate significant opportunities for spin-off economic activities.

5.1 Residential Benefits

If applied in its optimal configuration, IVDM™ technology can significantly improve the quality of home life in Alberta. Perhaps the greatest benefit for residential consumers is that they will have access to a greater number of more affordable electronic services than hitherto available. This is possible because IVDM™ technology effectively shares expensive hardware, software and bandwidth among the largest possible number of users and integrates many services over the same facility, thereby reducing the cost of providing new electronic media. This flows to home users in the form of lower tariffs, which will increase residential use of such electronic media as videotex, teletext and on-line database services. Indeed, recent user analysis tests at ISDN trial sites, such as Pacific Bell's Project Victoria, strongly suggest that residential consumers are more likely to use the new electronic services if access were more convenient and did not involve expensive dedicated terminals or modems, transmission speeds were faster, tariffs were lower and voice lines remained open at all times. All these features and more are readily available with residential IVDM™ technology.

Lower costs for new electronic services will likely generate increased residential interest in other new services such as telebanking and teleshopping. With IVDM™ technology, residential consumers will be able to conduct many non-cash banking transactions, directly from the home. This will make everyday life much more convenient for two-income earning families and

students whose schedules often conflict with normal banking hours or otherwise do not give them much time to shop during normal business hours. For senior citizens, handicapped individuals and house-bound persons, this would make banking more convenient as well as safer. Home teleshopping offers similar benefits. It will enable residential consumers to order groceries and other goods, with pre-arranged payment, and have them delivered directly to their homes.

If implemented in conjunction with the Smart House℠ wiring system, IVDM™ technology can also substantially enhance the safety of home life. Microprocessor-controlled power distribution virtually eliminates shock and fire hazard associated with short circuiting in conventional wiring systems. This is a crucially important consideration for households with small children and/or elderly family members. IVDM™ also delivers alarm monitoring services that are far more reliable than conventional security system offerings, at a fration of the cost (see Table 2). Medical alerts and burglar and fire alarms monitored by IVDM™ are not subject to the line failures or contention problems associated with telephone system-based security networks. As well, IVDM™'s energy management and appliance regulation features could reduce home energy costs by as much as 20-25% (Smart House Venture estimate).

IVDM™ also offers a very cost-effective method of implementing distributed computing power for home use. The remote location of the Personal Computing and Communications Service (PCCS) module enables the network operator to offer subscribers shared personal computing capability, at a fraction of the cost of purchasing or leasing stand-alone PCs (see Table 2). Subscribers can use standard colour television sets and wireless keyboards to access PCCS, and they pay for the service on a timed, per-use basis. PCCS could also greatly facilitate the development of working from the home, a phenomenon known as "telecommuting".

PCCS makes the concept of telecommuting a realistic possibility because IVDM™ enables home residents to interconnect with the information centres of employers and contractors on a cost-effective and convenient basis. The ability to carry out work assignments for one or more employers remotely from their place of residence means that individuals can work from the home. Typical work assignments for telecommuters are likely to include word processing, statistical analysis, accounting, database management and other such administrative and managerial tasks involving sofware packages. If implemented in a controlled fashion acceptable to prospective employers and contractors, telecommuting could generate significant cost savings relative to working out of an established place of business. Assuming that the average white-collar employee spends $ 2000 per year for transportation to and from a place of employment and that the employer spends $ 500 per year in office space for each employee, telecommuting could result in a net (after tax) savings of $ 2250 for each employee working from the home. If extrapolated onto a large group of telecommuters, say 10,000, the potential savings to both employer and employee alike could be enormous.

Telecommuting is ideally suited to single parents with small children, house-bound individuals and others who need to be at home during regular working hours. With IVDM™ high speed data communications between the home and a remote mainframe or mini-computer is delivered simultaneously with voice communications. This greatly facilitates the transfer of files between telecommuters and their employers or contractors. Telecommuting would greatly expand an individual's ability to carry out temporary work assignments and consulting services for more than one employer at the same time. This would indeed generate significant self-employment opportunities for residents of the "Electronic Cottage" in the new Information Age.

5.2 Economic Benefits

Increased residential use of new electronic media enabled by IVDM™ technology is likely to generate significant spin-off benefits for the local economy. In addition to telebanking and teleshopping, IVDM™ can deliver new home entertainment services such as electronic movie rentals, video games and musical libraries, all on compact discs, as well as electronic community bulletin boards. (For a complete description of these services and their features, see section 3.0). This will create many opportunities for new business ventures involving interactive services. It is interesting to estimate the possible number of direct jobs which could be created. Assuming 250,000 Edmonton residents are connected to an IVDM™ network and spend on average $ 15 per month for these new entertainment services (a conservative estimate), their expenditures would create approximately 450 new jobs. (This estimate is based on the information technology industry standard of one job per $ 100,000 in revenues to the service providers.) The development of the technology offers numerous direct and spin-off benefits to the Provincial economy in addition to those mentioned above. The Appendix details these direct, quantifiable benefits of the IVDM™ development program.

5.3 Educational Benefits

With the increasing utilization of computers in the classroom, it is now cost effective to link learning and work stations together into specialized educational networks. This will enable the provision of interactive information services, data processing and educational video services to the classroom and also will allow distance education networks to offer a greater, more diverse base of telecourses. Educational systems can also be linked with residential and commercial networks to deliver various educational services to the home and office, such as educational programming, interactive tutorials (on compact videodiscs) and on-line library research services. As with

business and other institutional settings, information and communication linkage at all educational levels will increase productivity for students, instructors and administrators alike, making educational programs more cost effective.

The educational field is a particularly exciting market for IVDM™ technology because it presents an environment where the System's major features can be fully exploited. Due to the sharing of computing resources in the network, IVDM™ offers the most cost effective approach for public and private educational institutions to increase the number of computing terminals for both instructional and administrative uses. Indeed, comparative cost analysis indicates a potential cost savings of $ 1000 per computerized learning/work station (see Table 2).

In sum, IVDM™ serves as the information network which links classrooms, schools and central offices, enables immediate high speed access to remote databases for research and instructional uses and, in the optimal synergistic configuration, allows users to interact with the surrounding residential, business and institutional communities. Such a network interconnection would greatly enhance the prospects for distance education, for education of the handicapped, senior citizens and other housebound individuals, and for on-site training and education of business and government employees.

6.0 RESIDENTIAL MARKET ASSESSMENT

6.1 The Residential Information Technology Market

TeleTronic market research has identified considerable sales potential for IVDM™ technology in the residential sectors of Canada, the United States, the United Kingdom and many other Western countries. Recent advances and decreasing costs in microchip technologies, deregulation of the communications industry in many jurisdictions, and the convergence of information processing and transmission have made communications the key to the new "Information Age". These developments have created potentially lucrative markets for integrated communication and information networks in the residential sector.

The convergence of computing and communication technologies has created new opportunities for both suppliers and users of communication and information networks. As the pace of technological change increases geometrically, the features and affordability of information technology products are rapidly improving. This has increased the number and range of electronic and entertainment services available for home use. Residential consumers are demanding improved levels of service from both telephone companies and cable TV operators. Consequently, traditional communication monopolies are weakening in the face of market driven forces and technological changes. These changes will have far reaching effects on the telecommunications industry through the 1990s as the Western world moves into the Information Age. Consequently, suppliers of communication equipment and services must adapt to increasingly complex and ever changing markets.

Management has targeted two geographic sectors with significant and immediate sales potential. They are:

(1) the two-way cable television and ISDN markets in Canada and the U.S. (IVDM™ 100, equipped to meet North American standards); and,

(2) the European broadband cable market (IVDM™ 800, equipped to meet international standards).

Depending upon the applicable communications regulations in the various national markets, the principal prospective buyers of residential IVDM™ are cable TV operators, broadband licencees (in the U.K.), multiple system operators (MSOs), residential property developers, national, regional and local telephone companies, European PTTs, and related communication service providers. Due to the practical limits to corporate growth and the lingering existence of foreign trade barriers in most Western countries, TeleTronic will make extensive use of joint ventures and technology transfer agreements with established communications corporations in markets such as Japan and West Germany. Without such a strategy, it is very unlikely that a new company such as TeleTronic will be able to penetrate many potentially lucrative foreign markets.

Due to the relatively small size of the Canadian market, IVDM™ will be marketed predominantly in countries belonging to the Organization for Economic Cooperation and Development (O.E.C.D), many of which are undergoing (to varying degrees) a transition from universal telephone service to universal multi-service, interactive information and entertainment networks. To this end, broadband coaxial cable and/or optical fibre networks are being installed in the following countries: the United States, the United Kingdom, France, West Germany, Switzerland, Austria, Belgium, Netherlands, Ireland, Denmark, Norway, Finland and Sweden. Residential IVDM™ technology will also be marketed in Pacific Rim countries with plans to develop cable TV in the future: Japan, Australia, New Zealand, South Korea, Hong Kong and Singapore. It appears that Hong Kong may pattern its upcoming communications reform upon Britain's liberal broadband regulations.

6.1.1 <u>The North American Residential Market (IVDM™ 100)</u>

In many jurisdictions throughout North America, telephone companies, cable TV and direct broadcast satellite systems are attempting to bring the home environment into an integrated

global network. Many leading CATV equipment manufacturers have developed addressable converters which enable one-way cable TV system operators to offer impulse pay-per-view TV (I-PPV), demand access video and other services such as home teleshopping, most often in conjunction with the telephone exchanges in the so-called "hybrid" systems.

In the United States some cable TV companies are now offering data communication services to both residential and business subscribers. As well, rural telephone companies with less than 2500 customers have a Federal Communications Commission (FCC) waiver to wire homes with integrated telephone and TV connections. If service offerings and deregulation continue on this course in the U.S., many residential cable TV systems are likely to be utilized in the future as integrated service networks for the joint provision of previously separate video and data services, and in some cases, voice as well.

Satellite communication networks and microwave relay systems are playing an increasingly important role in the provision of voice, video and data services, especially to remote and rural locations. In a deregulated environment, telephone companies will likely be forced to compete with cable TV operators in many residential areas. One possible solution for the telephone companies would be to upgrade existing networks with intelligent switching nodes and broadband transmission facilities and obtain regulatory approval to become common carriers, leasing bandwidth to independent information providers and cable TV operators.

TCL management believes that the current territorial of new interactive services which falls between the two monopoly positions of telephone service (telephone companies) and entertainment television (cable TV operators) will become a fiercely competitive battleground as potentially huge revenues are at stake. Once a market demonstration of the economic value of this middle ground has been shown, the imperative for both telephone companies and multiple system operators (MSOs) to install intelligent switching nodes in their systems (e.g. IVDM™)

will be unavoidable. As one telephone company executive aptly stated, "whoever has the smartest loop wins".

Communication regulations do not allow network operators to provide voice with video and data in most North American jurisdictions at the present time. Consequently, IVDM™ 100 installations configured to carry voice as well as video and data will be limited to remote and rural applications, franchises with special regulatory approval for integrated cable TV and telephone "drops", and private residential networks such as shared tenant services. However, it is not necessary per se to provide voice services. IVDM™ 100 can be implemented as a two-way cable TV system for the provision of impulse pay-per-view TV and various data services in conjunction with other video entertainment. In fact, the topology of IVDM™ 100C appears similar to that of a conventional coaxial cable TV system. As regulations are reformed to allow full service networks, two-way cable TV applications of IVDM™ 100 can be upgraded in the future to carry voice as well.

Just as it is not necessary to equip IVDM™ 100 for voice features, it is not necessary to provide entertainment video either. IVDM™ 100 can also be marketed as an ISDN system for telephone company applications, with the flexibility to add video capabilities at a later date. Fiberization of the subscriber loop in the telephone exchanges is anticipated to begin within ten to fifteen years. This will greatly enhance the bandwidth capabilities of the telephone system, far beyond that of coaxial cable. As fiberization takes place, communications regulations will likely be reformed to create a new role for telephone exchanges as <u>broadband common carrier networks</u>. Under this scenario, bandwidth will be leased to independent video, voice and data service providers. This will open the market for IVDM™ 100F fibre optic installations.

The Canadian market is estimated at $ 127.50 million through 1997. While this represents only 5.3% of IVDM™'s global potential in the residential sector, it is significant for the IVDM™ market entry strategy. Canada, and the Province of Alberta in particular, can provide high profile "showcases" for this advanced technology. TeleTronic has identified several opportunities in Alberta (and other Western Canadian provinces as well) for small scale, market entry IVDM™ applications in residential, educational, business and institutional applications. Supported by a high profile promotion campaign, market entry projects could generate considerable industry attention, attract investment capital and encourage the transfer of advanced information technologies into Alberta, thereby enhancing IVDM™'s prospects for success in the world market. Such a promotion campaign would also contribute to creating the image of Alberta as a centre for high technology development.

6.1.2 European Residential Market (IVDM™ 800)

As in North America, cable TV and direct broadcast satellite systems are gradually bringing European homes into an integrated information and communication network. Some European countries, in particular the Benelux countries, are among the most densely cabled areas in the world, and the provision of cable TV services has come to be viewed by many consumers as basic to home life as is universal telephone service. European consumers are also showing interest in home applications of new interactive information services as well as personal computing. This will have a profound impact upon the development and implementation of broadband ISDN in Europe.

Due to high installation and operating costs associated with traditionally separate voice, data and cable TV networks, it appears likely that broadband coaxial systems (and optical fibre facilities over the longer term) will be utilized to integrate all communication and information services over a single transmission network. Although Britain is the only country thus

far to liberalize residential communications and allow local broadband operators to offer voice and interactive data services in addition to cable TV, regulators in other European countries are beginning to realize the cost effectiveness and greater revenue bases enabled by broadband ISDN. France, West Germany and Denmark in particular have announced ambitious long range plans to install national broadband ISDN networks connecting all homes, offices, classrooms and institutions. The ultimate goal of these programs is to replace the conventional analog twisted pair telephone connections with broadband coaxial cables and, eventually, with optical fibres.

Many Post, Telephone and Telegraph (PTT) regulators on the Continent, as well as cable TV operators, are particularly interested in the enhanced revenue bases enabled by two-way broadband ISDN. In areas already connected to cable TV systems, some PTTs are proposing to upgrade existing operations with two-way capability and join them in a future national broadband facility which will serve as a common carrier information utility for the provision of all voice, video and data services. The Dutch PTT for instance is conducting a two-way cable TV experiment in the Province of Limburg. As well, the Danish PTT is cooperating with independent cable operators and three regional telephone companies in the installation of a national two-way broadband system known as the "Hybrid Network". It will be designed with digital technology from end to end to distribute cable TV, stereo, telephone and two-way data services to all Danish homes, classrooms, offices and institutions. Consequently, the prospects for sales of broadband ISDNs through the 1990s in Western Europe is enormous.

6.1.3 Other Residential Markets

IVDM™ 800 is equipped to meet international communication standards and therefore can be marketed outside of Western Europe in jurisdictions which conform to CCITT standards. Several countries in the Pacific Rim for example are planning to develop

residential broadband ISDN during the 1990s - Japan, South Korea, Singapore, Australia and New Zealand. Of these, Japan has made the most progress thus far.

In a manner very similar to the British model, privatization and liberalization of the telecommunications industry in Japan has created a multitude of opportunities for new products and services involving ISDN applications. The Japanese Government is actively pursuing the installation of an Information Network System (INS). Scheduled for completion by the year 2000, INS will be a single communications network based entirely on digital technology from end to end, designed to distribute a full range of transmissions (e.g. telex, telefax, telephone and computer data) which currently are carried in different forms and often on different physical lines. The INS will gradually encompass Japanese homes as well. Pending the commercial development of recent advances in fibre optic technologies, this national network will eventually distribute digitized TV for wide screen viewing in individual homes.

The recently privatized Nippon Telephone and Telegraph (NTT) is currently conducting its own 2000-user Integrated Network Services trial in Mitaka, a suburb of Tokyo. Although residential consumer response to home banking and teleshopping has fallen short of NTT's expectations, there are plans to conduct similar trials in other localities including the Tokyo suburb of Tama as well as Higashi Ikoma near Osaka. NTT planners are optimistic that high definition television broadcasting for wide screen viewing will attract considerable consumer interest over the long term.

Consequently, it is anticipated that future residential broadband ISDN trials in Japan will utilize optical fibres as the transmission medium in switched star configured networks. NTT is currently conducting a fibre optic ISDN trial in the Marunouchi business district, which is parallel to the Mitaka trial and utilizes 400 Mbps fibre optic transmissions to connect the two sites. Further developments in optical fibre technologies will

create significant marketing opportunities in Japan for fibre optic IVDM™ 800F installations.

6.2 Residential IVDM™ Sales Forecasts

Total sales of IVDM™ 100 and IVDM™ 800 over time most likely will follow a normal distribution. This is consistent with the product life cycle characteristics exhibited by virtually all successful high technology products. Although recent high technology products have been exhibiting progressively shorter life cycles, IVDM™ most likely will experience a longer life cycle. This is attributable to IVDM™'s modularity (which will enable future upgrades to accomodate technological improvements) and to its capability to support all types of transmission media - twisted copper pairs, coaxial cable, fibre optics, cellular, microwave, satellite, etc. Consequently, TeleTronic can safely estimate a twenty-year life cycle for residential applications of IVDM™ technology.

As the normal distribution is both cumulative and symmetrical, one-half of total sales will occur during the first ten-year period and one-half during the subsequent ten-year period. For each national market, cumulative sales are forecast by first estimating potential subscribers over a projected 10-year horizon. Forecasts of potential subscribers in each country are based on judgmental extrapolation of relevant historical data obtained from various public sources. The forecasts are subject to a number of factors including regulatory conditions and anticipated future reform, average income level, plans for upgrades and additions to public communication networks, penetration rates for personal computers, etc., all of which vary from country to country.

From estimated potential subscribers, TCL management has projected cumulative market penetration ratios for IVDM™ not exceeding 5% within each country. From this, total unit sales estimates are derived and converted to their dollar values at

$ 1000 per subscriber. The resultant cumulative sales estimates are distributed within the ten-year frame of the normal approximation according to the assumptions of the model, and annual equivalencies are derived by calculating the change in cumulative sales for each year. Based on this methodology, management estimates cumulative sales potential for residential IVDM™ at $ 2.39 billion through 1997, exclusive of sales opportunities in Pacific Rim and developing countries. Projections for each geographic market are presented on the following graphs.

7.0 THE INTERNATIONAL REGULATORY ENVIRONMENT

Despite the economies of scale and lower costs of providing voice, video and data services with ISDN, regulatory constraints in most Western countries continue to delay their full-scale implementation, especially in the residential sector. The traditional pattern of government owned or controlled communication monopolies is not easily overcome by market-driven forces. Reforming and deregulating the once "natural" monopolies presents a number of problems.

One set of problems which has hampered the pace of reform, most notably in Western Europe, is political and social in nature. Arthur D. Little, Inc. has identified these obstacles to regulatory reform. Publicly owned telephone systems contribute significantly to many national budgets - DM4 billion per year in West Germany and FFr17 billion per year in France. Consequently, the governments concerned are not terribly eager to forfeit these revenues, especially while faced with rising national debts. Moreover, the Post Telephone and Telegraph (PTT) administrations employ many people - 500,000 are employed by West Germany's Bundespost, making it the largest single employer there. Naturally, there are tremendous union and political pressures for maintenance of the status quo, especially with the unemployment malaise confronting much of Western Europe. And finally, telephone service customers have become accustomed to low local

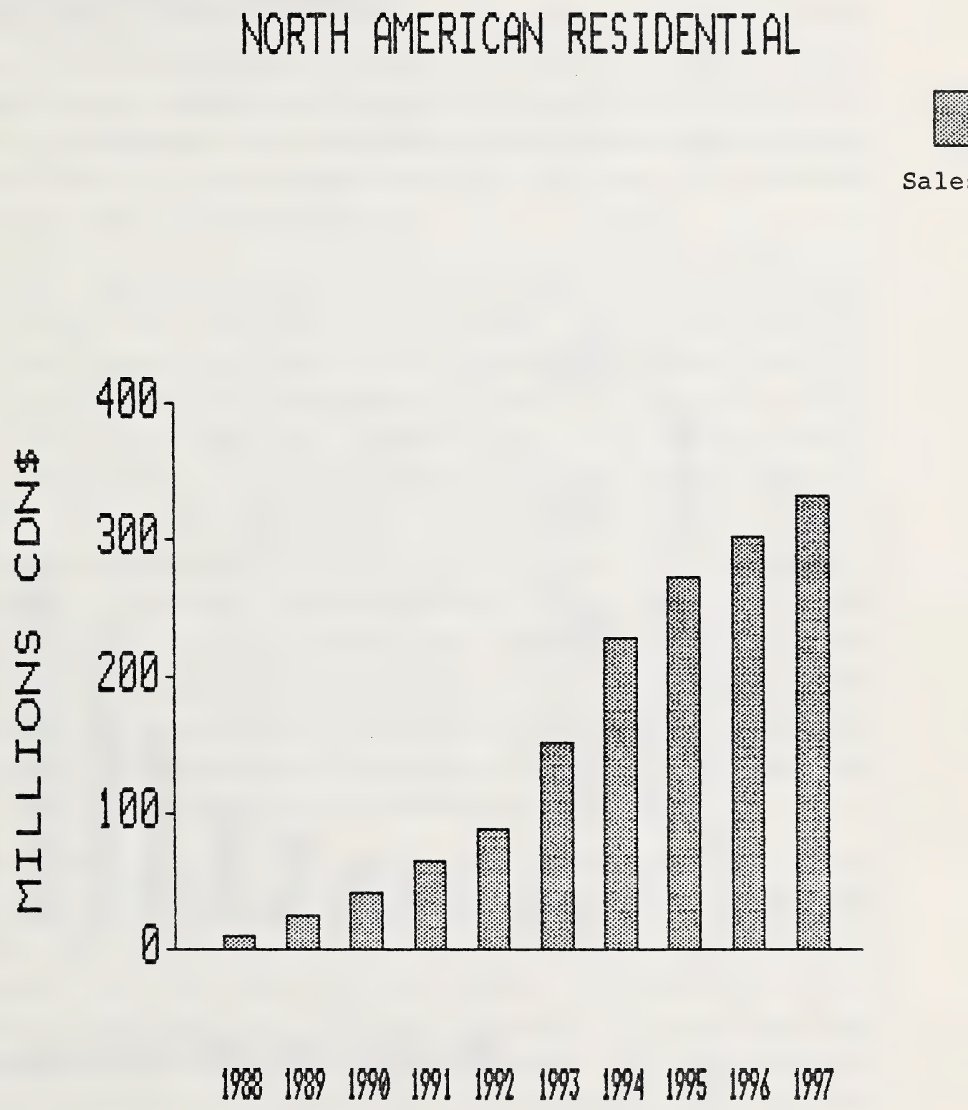


Figure 5: North American Residential Sales

ANNUAL SALES FORECASTS 1988-1997

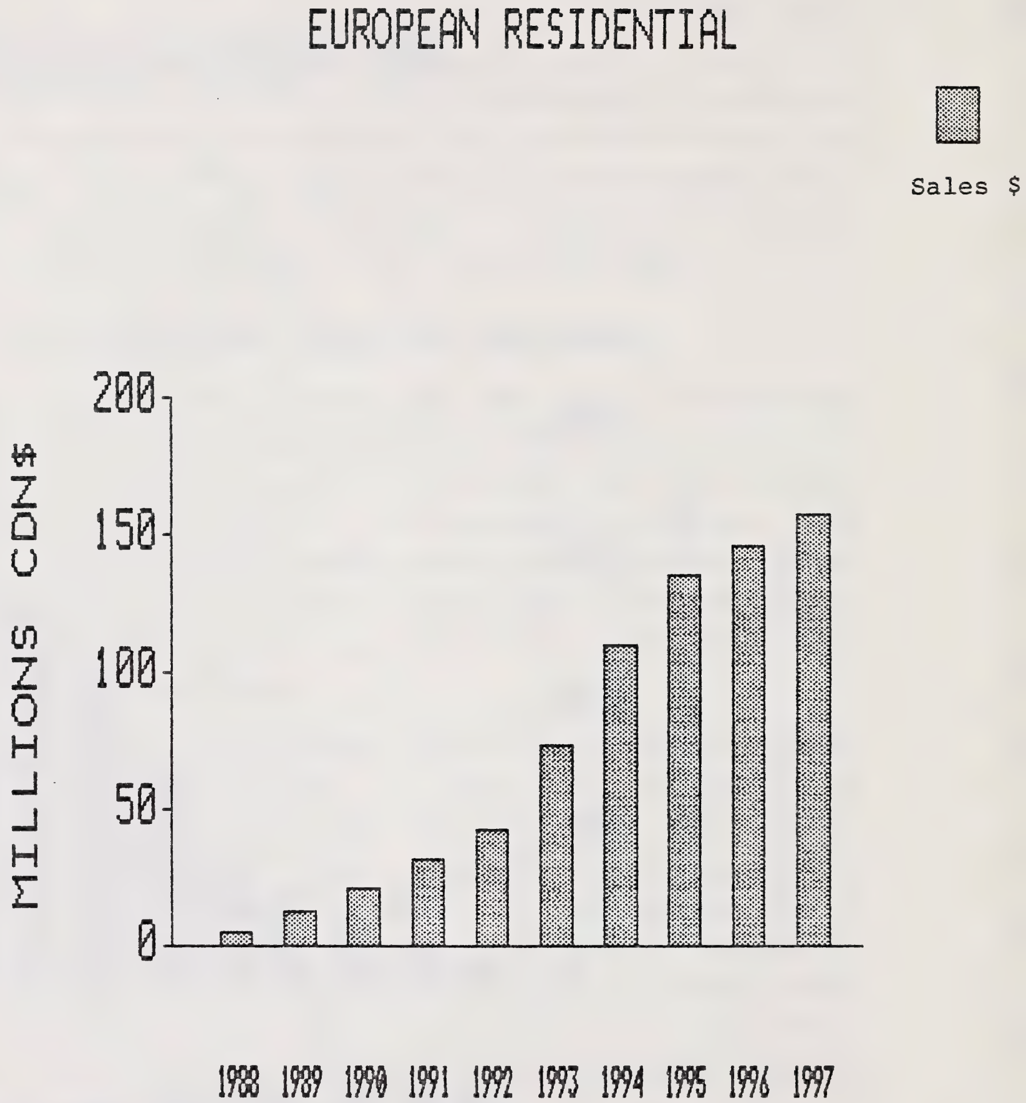


Figure 6: European Residential Sales

ANNUAL SALES FORECASTS 1988-1997

service rates which bear little resemblance to actual costs, a condition which could not continue under privatization.

The second problem associated with reform of the telecom monopolies is that unharnessing them will amount to their subsequent entry into a competitive market with an unfair advantage - billions in ratepayer and government subsidized plant investment. New entrants in the communications equipment and service markets hardly share this advantage.

The third difficulty has to do with the uniform technical standards by which the networks are operated. Their uniformity in regards to the connectibility of peripheral equipment and user terminals to the network is essential if the new services are to be compatible across national boundaries. This never posed a problem in the monopolistic framework. However, with computer service companies and the mixed scenario of regulated and deregulated telecommunication service providers, it is indeed a serious consideration, particularly with international transmissions. It is anticipated that ongoing research in the International Standards Organization and the CCITT into formulating global standards for Open Systems Interconnection (OSI) and Open Network Architectures (ONA) will eventually establish a set of consistent international standards.

Nonetheless, the multiple problems associated with telecommunications liberalization more than likely will extend the life of the remaining monopolies as they now exist. There is very little doubt that they must be reformed, but there is still considerable controversy as to how reform will be implemented. The economic changes which are forcing computer and telecommunications companies to compete in networking and systems integration indeed are undermining the communications regulatory structure, but the process of change will likely be slower than originally anticipated. The resultant social and economic transformation caused by this process will prove to be as significant for the telecommunications industry as will be the fiberization of the subscriber loop.

7.1 The Regulatory Environment in Canada

At present, telecommunications in Canada are regulated by the Canadian Radio-Television and Telecommunications Commission (CRTC), a federal body with national jurisdiction, and also by applicable provincial public utility boards (PUBs). Jurisdiction over domestic telephone companies has been shared among the federal and provincial governments since the first telephone lines were installed over one hundred years ago. At that time, the Canadian Parliament declared that the two largest telephone companies, Bell Canada and the British Columbia Telephone Company, were to be regulated at the federal level because they served the largest collective group of users and because such a large number of calls made over their exchanges were interprovincial or international. The regulation of intra-provincial calls made through the other nine telephone companies was left to the provincial authorities, with the CRTC only exercising control over interprovincial connections and access to the national network.

With the advent of radio and broadcast television, the scope and responsibility of communications regulations expanded greatly. At that time, both radio and television signals were transmitted "over the air", totally separate from the telephone exchange. It therefore made technical sense to regulate telephone calls, television signals and radio transmissions as separate media altogether. The telecommunications industry was therefore divided on the basis of type of service (voice or video) and by locality. Accordingly, intraprovincial telephone transmissions were to be regulated by the PUBs, whereas radio and television were to be regulated by the CRTC.

This regulatory approach made practical sense until the development of one-way coaxial cable television systems capable of transmitting both radio and television signals. More recently, the situation has been further complicated by the computer revolution, advances in digital transmission techniques, the exploitation of two-way communication capabilities inherent

in coaxial cable TV systems, the introduction of new interactive services, and the growing demand for data communications over public as well as private networks. These and other related developments have blurred the traditional regulatory boundaries between voice, video and data transmissions and accordingly have presented policy problems for the communication authorities in Canada.

Under the current telecommunications regulatory framework, jurisdictional control is highly fragmented. Different rules apply to users in various parts of the country. The degree of competition and freedom to use new technologies and services allowed in federally regulated areas is denied to users elsewhere. The Federal Department of Communications wants to standardize rules for competition and network access for all jurisdictions. Yet at the same time it is proposing to relegate intraprovincial activities of the federally regulated telephone companies to the provincial authorities. This has been criticized as being inconsistent with the goal of harmonizing federal and provincial policies and ensuring just and reasonable access to telecommunications services and networks in all parts of the country. Federal and provincial regulators are expected to reach a consensus soon on these and other related issues.

While the proposed changes to the current regulatory regime do not specifically address the future of ISDN in Canada, they are likely to set the stage for further reform. The development of interactive services has caught the attention of the CRTC, which is expected in the near future to issue a policy paper on the implementation of pay-per-view television services. Since the Canadian industry is committed to maintaining a high level of service and reliability for users, regulators are anxiously watching ISDN developments in Western Europe and the United States in order to maintain compatibility with international networks. Thus, the direction of further reform in Canada depends somewhat upon reform in other Western countries.

7.2 Regulatory Reform in the United States

Although much has been made of the positive side effects of telecommunications deregulation in the United States since the 1984 divestiture of AT&T, the only segment of the American industry which has experienced truly effective deregulation has been the long distance telephone market with the entry of competitive service providers. In fact, the twenty-two local operating companies left over from the AT&T split-up have inherited not only the divested AT&T plant but also the monopoly positions over local telephone services within their respective geographic franchises. These franchises still remain subject to extensive government regulation by the state regulatory agencies and by the Federal Communications Commission, the national telecommunications regulatory body in the United States.

The seven regional holding companies, of which the respective local operating companies are a part, are allowed to sell but not produce telecommunications equipment. Yet they are permitted to enter other related businesses, such as cellular mobile telephone services, international service sales and systems integration networks (subject to Court approval). However, the holding companies are not allowed to offer data processing services over the local network.

The Federal Communications Commission (FCC) has granted only a very few of the local telecom providers the permission to carry cable television and other services in addition to telephony within their geographic franchises, and then only in remote and rural locations or field test sites. Thus, despite deregulation and reform, the U.S. telecommunications industry remains segregated on the basis of both geography and type of telecom service. If the concept of ISDN is ever to be implemented fully on a large scale such that every home, office, classroom, institution and the like are to be interconnected by a national, if not global, network encompassing more than standard telephone and cable television services, deregulation must proceed much further.

7.3 Regulatory Reform in Western Europe

Communications in most European jurisdictions are regulated by post, telephone and telegraph (PTT) authorities. As in North America, the regulatory framework is confronted by market-driven economic and technological forces. Two structural failures are weakening the European telecommunications structure: outdated investment objectives and pay-back criteria, and market fragmentation. Investment in telecommunication equipment has traditionally been directed into schemes which generate short-term pay-backs and large cash flows. The emergence of new services, value-added networks and leased lines are particularly problematic for these network investment objectives. Another problem is market fragmentation on the basis of national network. Different national network standards as well as national source favouritism in equipment testing and certification also increase development and marketing costs. Consequently, it is no real surprise that European telecommunications equipment manufacturers are prepared to fight "hammer and tooth" for the maintenance of the protectionism inherent in the regulatory status quo. As for the PTT monopolies, liberalization and deregulation undoubtedly would create the need for a total reversal of traditional capital investment patterns, pricing practises and cost control measures.

Mr. Henry Ergas of the Organization for Economic Cooperation and Development argues that of the industry's two deregulatory trends, liberalization and privatization, the latter is more likely to be the eventual outcome on the Continent, similar to the British and Japanese examples. Privatization treads on no important toes. The government receives plenty of cash, the new private shareholders are relatively well assured of profitability, and the leftover bureaucracy is freed of excessive government supervision without the drawbacks of free competition. Market liberalization, on the other hand, is likely to be confined to the office communications equipment and value added network service sectors, if only because their growth will stimulate increased usage of the basic networks.

7.4 Regulatory Reform in the United Kingdom

Of all the communication regulatory frameworks in Western Europe, the British model represents perhaps the most extensive and effective program of privatization and regulatory reform to date. The Conservative Government's sale to the general public in 1984 of 50.2% of British Telecom's (BT) outstanding shares left the telecommunications giant fully intact, unlike the AT&T divestiture one year earlier. Only Mercury Communications, a wholly owned subsidiary of Cable & Wireless, was given a share of the long distance telephone market. The privatization program authorized the leasing of BT circuits but not their resale. The office equipment market was liberalized completely so that any company can manufacture and sell hardware such as private branch exchanges, albeit subject to certification and testing procedures of an agency technically independent of but friendly to BT. As part of the deal, the government established an independent body known as the Office of Telecommunications (OFTEL) to regulate BT.

The director of OFTEL, Mr. Bryan Carsberg, professes that his principal role there is to promote competition further. He maintains that future reforms in the telecommunications regulatory regime might include such specifics as leased line resale, the separation of BT's equipment and service marketing organizations, and perhaps even divestiture of BT itself (though highly unlikely). Review of the present framework is scheduled for 1989, and it is very likely that bypass and leased line resale will be authorized. It is also likely that foreign service providers will be allowed to assume minority interest positions in Mercury and other long distance competitors of BT.

While the telephone industry in the United Kingdom has experienced considerable regulatory reform relative to its counterparts on the Continent, the residential cable television industry has witnessed more far-reaching deregulation and reform. This is highly significant for the development, design and implementation of broadband ISDN in Britain. The liberalization of the cable television industry has proceeded as an integral

part of the overall telecommunications liberalization program. The Conservative Government in 1984 established the Cable Authority as a separate regulatory body for the residential cable industry to emphasize that sector's importance in the new telecommunications policy.

Part of the Cable Authority's mandate is to promote the public image of cable systems as more than television programming networks. The cable regulatory legislation specifically authorizes local franchises to offer their residential subscribers interactive services such as personal computer and data processing services, videotex, teleshopping, telebanking, electronic mail, etc., as well as local telephone service, in addition to cable television. This ambitious national cabling program promises to integrate the subscribing British household into the national communications system which will ultimately link all households, offices, classrooms and institutions into a single national network, segregated only by locality. Such a regulatory approach is ideal for broadband ISDN.

7.5 Regulatory Reform in Japan

The Japanese liberalization program has followed closely the British model of privatization rather than American divestiture. In April 1985 Nippon Telegraph and Telephone (NTT) was converted from a public agency into Japan's largest private corporation. There are two sources of competitive pressure being brought to bear upon NTT - alternative long-distance carriers and foreign equipment purchases for value-added networks. Five alternative long-distance carriers already have been approved, and another's application is awaiting final clearance. With the prospect of increasing competition in the market, NTT's long-distance tariffs have been declining in response to the entry of other carriers who are planning to charge long-distance calls on heavy traffic routes at rates 70-80% of the NTT tariffs. Just how far the long-distance rates will fall is largely a matter of

the charges which NTT will be allowed to levy against the other carriers for connection to the local networks.

The value-added network market in Japan similarly is experiencing increased competition. Both NTT and its long-distance competitors are allowed to lease their facilities to general and special value-added network providers. General value-added networks originally were intended for small-company data processing systems, which have been allowed in Japan since 1982 and are essentially free from regulation. Yet as deregulation has proceeded through 1985, the scope of general value-added networks has been expanded to include almost any size of data processing network provided that access to it is not available to the general public. Consequently, the number of general value-added networks has grown to over 170. An example of a special value-added network in Japan would be an electronic home-shopping network. They are subject to more government regulation than the general type, and the Ministry of Posts and Telecommunications reports that only eight applications to provide special value-added networks have been submitted thus far. This is most likely attributable to the liberal definition currently applied to the general type.

Foreign companies attempting to break into the Japanese telecommunications market have been most successful with equipment sales to value-added network providers. In fact, NTT itself has negotiated with IBM for the purchase of computer equipment that will be used for the operation of a special type value-added network. Competitive developments such as this are bound to upset NTT's circle of traditional telecom equipment suppliers, such as NEC and Fujitsu, both of whom lobbied strongly against renewal of Mr. Shinto's contract in 1984. Nevertheless, increasing demand for value-added network services in Japan is bound to result in higher foreign equipment sales given the government's relaxation of import testing and certification procedures. This initial penetration is likely to provide the foreign companies with a sufficiently well established market position which will

facilitate their participation in the provision of telecom equipment and related software for the Information Network System, the focal point for government's master plan to transform Japan into an information-based economy by the end of this century.

7.6 Prospects for Further Reform

It appears that regulatory constraints in many Western countries will present obstacles for the large scale implementation of ISDN, at least for the short run, until further reform and market liberalization finally transpire. However, over the longer term, prospects for reform are indeed promising, for nearly all Western countries have made national committtments to the recabling of existing communication networks. The common goal of these national programs is eventually to link all households, classrooms, offices and institutions into a single network which will distribute the full range of communications and information services which at present are often carried on different physical lines.

In Denmark for instance, despite the lingering presence of cumbersome telecommunications regulations, the national government is embarking upon an ambitious cabling program for the implementation of a national ISDN which the Danes refer to as the "Hybrid Network". This network will be designed, developed and operated to provide Danish households and commercial and industrial concerns with telephone, data communications, cable television and radio signals, all through one cable connection to the system which will use a combination of coaxial cable and optical fibres. Interestingly enough, the three regional Danish telephone companies will oversee the implementation of this major project.

Similar national commitments in Japan, the United Kingdom, Switzerland, France, West Germany, Canada, Belgium, the Netherlands and the United States are all predicated upon further regulatory reform. Consequently, it is only a matter of time before the traditional telecommunications regulatory frameworks

succumb to the market-driven economic and technological changes which are transforming the Western countries into the information-based societies of the twenty first century. What is needed is a regulatory framework which will establish consistent and compatible technical standards across all national networks and subdivide the telecommunications market on the basis of locality alone and not by type of service as well. In other words, what is needed in each country is a national, public broadband ISDN operated as a common carrier utility, where bandwidth is leased to independent communication and information service providers. Unfortunately, this scenario is not possible under the current state of regulatory reform in most jurisdictions. Further reform and deregulation are inevitable because telecommunications is without question the key to the ascending Information Age.

7.7 Implications for Residential IVDM™

Despite the presence of regulatory obstacles, the successful implementation and operation of IVDM™ field trials and market entry projects will demonstrate the economies of scale and resultant cost savings associated with residential broadband ISDN. Consequently, they are likely to generate favourable attention within regulatory circles. TeleTronic plans to take advantage of high profile IVDM™ "showcases" and attract the attention of regional, national and international regulators. TeleTronic will support this promotional effort by responding to regulators' periodic requests for public commentary on such issues as interexchange competition, open network architecture designs, and ISDN operational standards, with the objective of encouraging future regulatory reform that is favourable to the large scale implementation of broadband ISDN. In order to facilitate the installation of IVDM™ market entry projects, TeleTronic will take all possible steps to assist buyers in their efforts to overcome applicable regulatory obstacles.

APPENDIX

APPENDIX

One of the key benefits of the IVDM™ technology development program is the anticipated significant use of the Alberta high technology infrastructure largely put into place by the efforts of the Federal and Provincial governments. TeleTronic has established various corporate relationships with such Alberta organizations as LSI Logic Corporation Canada Inc., the Alberta Microelectronic Centre, the Alberta Laser Institute and others. TeleTronic's development expenditures will be channelled into these organizations, further enhancing their prospects for success. TCL Management has identified the following organizations as providers of goods and services (including staff) during various development stages:

Alberta Government Telephones
Alberta Laser Institute
Alberta Microelectronic Test Centre
Alberta Research Centre
Alberta Telecommunications Research Council
Canutel
"edmonton telephones"
LSI Logic Corporation Canada Inc.
Electronic Test Centre
Local electronic suppliers
Northern Alberta Institute of Technology
University of Alberta
University of Calgary

The use of this infrastructure means that TeleTronic's research and development expenditures (approximately $ 114 million through 1991) will strengthen and promote growth in these private and public sector organizations. The development program will also create meaningful long-term employment opportunities for many skilled Albertans. It is anticipated to create approximately 6210 man-years of employment through 1991. The development program also will generate significant financial benefits for the

three levels of government. Through 1991 approximately $ 100.7 million is expected to be paid in taxes and payroll charges.

In addition to the direct use of the high technology infrastructure, the IVDM™ development program will generate considerable spin-off activities in many economic sectors:

MANUFACTURING - best efforts will be used to source Albertan manufactured goods including printed circuit boards, circuit board assembly, LSI chips and electronic components.

SOFTWARE - major development of software services for residential uses (PPV-TV, videotex, telebanking, etc.) as well as office automation, industrial, institutional, educational, medical and security applications.

INTERNATIONAL EXPORTS - As IVDM™ 100 and 800 will be predominantly exported, their development within the Province is likely to provide the "backbone" of an international telecommunications, software, hardware and engineering services marketing consortium comprised of many Albertan companies.

OTHER - attraction of investment capital, diversification of the Provincial economic base, increase in international export and finance expertise, enhancement of Alberta's high technology image and improvements to distance education.

Both the Federal Department of Communications and the Alberta Department of Technology, Research and Telecommunications have acknowledged the merits of developing and exploiting IVDM™ technology. TeleTronic's development plan is consistent with the Province's strategy of diversifying the Provincial economy through the commercial development and application of advanced information technologies, as described in the Government's 1985 White Paper. Applying IVDM™ advanced communications and information processing capabilities in the energy and manufacturing sectors, for instance, could greatly enhance the productivity and competitiveness of Alberta industry.

Many related technologies and peripheral hardware will be interfaced with IVDM™ throughout the development program. This will include advanced technologies which will be imported into Alberta, with long term as well as immediate potential benefits. This process in fact has already begun with the transfer of microwave technology from the United States. Microwave relays enable IVDM™ to be cost effectively extended to rural and remote areas. Such an application within rural Alberta would greatly enhance communications capabilities of the agricultural sector. The following table quantifies only the direct and immediate benefits of developing IVDM™ technology in Alberta.

Table 4

Schedule of Government Benefits

TELETRONIC COMMUNICATIONS LTD.
SCHEDULE DEPICTING BENEFITS TO GOVERNMENTS FOR
SUPPORTING IVDM TECHNOLOGY DEVELOPMENT IN ALBERTA
($000's Cdn.)

	1986	1987	1988	1989	1990	1991	TOTALS
SALES PROJECTIONS	.0	6,000.0	33,000.0	82,000.0	150,000.0	248,500.0	
R&D EXPENDITURES (PROJECTS)	7,132.0	18,700.0	18,000.0	12,396.0	11,100.0	5,000.0	
R&D EXPENDITURES (8% SALES)	.0	480.0	2,640.0	6,560.0	12,000.0	19,880.0	
TOTAL R&D EXPENDITURES	7,132.0	19,180.0	20,640.0	18,956.0	23,100.0	24,880.0	113,888.0
MANPOWER:							
MAN YEARS-R&D PROJECTS	49.0	145.0	158.0	93.0	83.0	37.0	
MAN YEARS-R&D ON SALES	.0	4.0	23.0	58.0	106.0	176.0	
TOTAL R&D MANPOWER	49.0	149.0	181.0	151.0	189.0	213.0	932.0 (man-years)
MANPOWER TO SUPPORT MFTG./MKTG./ADMIN. ETC	.0	61.0	335.0	833.0	1,524.0	2,525.0	5,278.0 (man-years)
TOTAL MANPOWER REQUIREMENTS	49.0	210.0	516.0	984.0	1,713.0	2,738.0	6,210.0 (man-years)
GOVERNMENT BENEFITS RESULTING FROM THIS JOB CREATION:							
-UIC BENEFITS SAVED (1ST YR.)	699.7	2,503.2	4,757.7	7,276.5	11,334.5	15,936.7	
-UIC PREMIUMS-EMPLOYEE	29.6	127.1	312.2	595.3	1,036.4	1,656.5	
-UIC PREMIUMS-EMPLOYER	41.5	177.9	437.1	833.4	1,450.9	2,319.1	
-CPP PREMIUMS-EMPLOYEE	20.5	88.0	216.2	412.3	717.7	1,147.2	
-CPP PREMIUMS-EMPLOYER	20.5	88.0	216.2	412.3	717.7	1,147.2	
-FEDERAL INCOME TAXES	239.2	953.2	2,123.5	3,820.1	6,563.0	10,384.8	
-FEDERAL SALES TAX	.0	184.7	369.5	739.0	1,662.7	2,586.4	
TOTAL BENEFIT- FEDERAL GOV'T	1,051.1	4,122.0	8,432.3	14,088.9	23,482.9	35,177.9	86,355.1
-PROVINCIAL INCOME TAXES	104.1	414.6	923.7	1,661.7	2,854.9	4,517.4	
-W.C.B. PREMIUMS	15.4	63.4	147.5	272.5	471.0	748.8	
TOTAL BENEFIT-PROV. GOV'T	119.5	478.0	1,071.2	1,934.2	3,325.9	5,266.3	12,195.1
FACILITIES: SPACE REQUIREMENTS:	7,350.0	31,500.0	77,400.0	147,600.0	256,950.0	410,700.0	
FACILITIES: ANNUAL COSTS	36.8	157.5	387.0	738.0	1,284.8	2,053.5	
MUNICIPAL GOV'T BENEFITS:							
-PROPERTY TAXES	12.5	53.6	131.6	250.9	436.8	698.2	
-BUSINESS TAXES	4.5	19.1	46.9	89.4	155.7	248.8	
TOTAL BENEFIT-MUNICIPAL GOV'T	16.9	72.6	178.5	340.4	592.5	947.0	2,147.9
TOTAL BENEFITS- ALL GOV'TS	1,187.5	4,672.7	9,681.9	16,363.5	27,401.3	41,391.2	100,698.2

NB: Please refer to the ASSUMPTIONS FOR GOVERNMENT BENEFITS in the APPENDIX for the assumptions used and the rates used in determining these amounts. Also refer to the EMPLOYEE PROFILE FOR TAXATION PURPOSES found in the APPENDIX to support the calculations for income taxes.

NB: The above figures are ONLY for DIRECT, IDENTIFIABLE BENEFITS from within TeleTronic alone, to be realized by the Governments of Canada and Alberta for supporting the development of this new industry.
The above does not include any spin-off benefits. Further INDIRECT or SPIN-OFF benefits would be realized as a result of the following factors:

1. The spending of the disposable income of TeleTronic's employees (est. at over $150 Million in the first six years alone)
2. TeleTronic's expenditures to other Canadian and Albertan companies and public institutions in the high-tech. infrastructure (est. at over $160 Million during the first six years alone)
3. The spin-off benefits associated from #2 above, including additional employment, additional profits, additional capital expenditures, additional disposable income of the additional employees of these firms, additional taxes , etc......

We make no effort to try to establish a value for the total magnitude of all of these benefits, except to state that the multiplier effect would produce some very impressive numbers.

Table 5:

Assumptions Used in Determining Benefits

TELETRONIC COMMUNICATIONS LTD.

ASSUMPTIONS USED IN DETERMINING THE

SCHEDULE OF GOVERNMENT BENEFITS

1) As this is a new firm, new technology and in essence the beginning of a new industry, it is assumed that all jobs created in TeleTronic will not be at the expense of a job lost somewhere else in Canada. Therefore, it follows that all positions created will directly result in a reduction of the number of people collecting unemployment insurance benefits to the maximum of $299 per week per employee for fifty-two weeks each.

2) UIC premiums are based on 1986 maximums of $605 per employee per year.

3) CPP premiums are based on 1986 maximums of $419 per employee per year.

4) Income taxes - we have developed two profiles we consider would be the average employee type for taxation purposes (see PROFILE). It is assumed that R&D employees will approximate the $35,000/year profile while all remaining employees, on an average, will approximate the $30,000/year profile.

5) Facilities - it is assumed that the facility requirements are equivalent to 150 square feet per employee, at an average cost of $5.00 per square foot.

6) Property taxes are based on a rate of $1.70/sq.ft. Business tax is based on a rate of 12.118% of annual cost for facilities.

7) It is assumed a total manpower requirement (not including the R&D component to support identified projects) of one employee for every $92,000 in sales. This figure is based on statistics received from the CANADIAN ADVANCED TECHNOLOGY ASSOCIATION.

Table 6:

Profile of Average Employee

TELETRONIC COMMUNICATIONS LTD.
PROFILE OF THE EXPECTED AVERAGE EMPLOYEE
FOR TAXATION PURPOSES

	$30,000/YR (MFTG/MKTG/ADMIN)	$35,000/YR (R&D)
GROSS WAGES:	$30,000.00	$35,000.00
LESS EMPLOYMENT EXP. DED.	($500.00)	($500.00)
PLUS FAMILY ALLOWANCE	$330.00	$300.00
TOTAL INCOME FOR TAX	$29,830.00	$34,800.00
LESS CPP	($419.00)	($419.00)
LESS UIC	($605.00)	($605.00)
NET INCOME	$28,806.00	$33,776.00
LESS BASIC EXEMPTION	($4,180.00)	($4,180.00)
LESS MARRIED EXEMPTION	($3,660.00)	($3,660.00)
LESS EXEMPTION- ONE CHILD	($710.00)	($710.00)
TAXABLE INCOME	$20,256.00	$25,226.00
FEDERAL INCOME TAX	$3,700.98	$4,882.00
PROVINCIAL INCOME TAX	$1,609.93	$2,123.67
TOTAL TAX	$5,310.91	$7,005.67
DISPOSABLE INCOME (NET INCOME LESS TOTAL TAXES)	$23,495.09	$26,770.33